



Department of Pathology

RISING TO THE CHALLENGE 2020

Rising to the challenge: a message from the department head



I AM BOTH DELIGHTED and proud to present the 2020 Dalhousie Department of Pathology annual report. In our first professionally produced report, we hope to shed more light on pathology's crucial role in medicine.

It has been traditionally noted that approximately 70 per cent of all clinical decisions are based on laboratory testing information. Pathology laboratories in Nova Scotia's Central Zone alone conduct upwards of eight million tests a year. When you add the labs in other parts of Nova Scotia and the Maritimes, that number would probably triple. This is staggering when you think of it! Where would our attending physicians be, how would they diagnose and prescribe in the absence of the sure knowledge pathology provides?

With the arrival of COVID-19 in early 2020, the role of pathology has become that much more important. As you will read in this report, department members and our microbiology staff stepped up with courage and creativity to overcome shortages of key supplies and the human resources needed to rapidly increase our testing capacity to almost ten times normal volumes. Our "all-hands-on-deck" testing efforts have been a key to Nova Scotia's and the Maritimes' ability to keep our case counts low and our people safe. I am so grateful to the many people who are making it possible.

Pathology is about more than identifying pathogens or cancers and involves teaching and research as well as patient care and serving and engaging society. Our members are leading a regional system of biobanks that provides a strong foundation for basic science, clinical trials, and personalized molecular medicine. And, we are making enormous strides in genomic testing that will help families coping with inherited diseases that are often the cause of profound disability and even early death. Major national granting agencies are supporting these efforts, which are key contributors to strategic pan-Canadian initiatives. All the while, we are training the next generation of clinical and research pathologists, with around 50 trainees in our department at any given time.

In addition to the stories reported in this document, the Department of Pathology is increasing the efficiencies of laboratory services by implementing automation in the microbiology and cytology laboratories, with funding from Nova Scotia Health. We are also advancing molecular testing for cancer, and will receive funding from the Canada Foundation for Innovation to establish a histology core research facility in the Tupper Building.

Even though these are challenging times, they are also exciting times for the Department of Pathology. Our department members, staff and learners have shown how resilient, innovative and dedicated they are, and the importance of our role has never been quite so appreciated. I hope you enjoy this report of our activities and look forward to any feedback you may have.

Sincerely,

Dr. Irene Sadek

Dr. Irene Sadek

CLINICAL
WORKLOAD**16,528,465**TOTAL NUMBER OF
TESTS PERFORMED**935,353**TOTAL BLOOD
COLLECTIONS PERFORMED

PEOPLE

86NUMBER OF
PRIMARY FACULTY**25**CROSS APPOINTED
FACULTY**8**ADJUNCT
FACULTY**654**NS HEALTH
TECHNICAL STAFF**111**IWK TECHNICAL
STAFF**177**NB TECHNICAL
STAFF

RESIDENTS

26TOTAL NUMBER
OF RESIDENTS**9**ANATOMICAL
PATHOLOGY**7**GENERAL
PATHOLOGY**6**HEMPATO-
PATHOLOGY**4**MEDICAL
MICROBIOLOGYGRADUATE
STUDENTS**27**TOTAL NUMBER
OF GRADUATE STUDENTS**13**

PhDs

9

MSc

5

PDFs

RESEARCH
STATISTICS**249**NUMBER OF
PUBLICATIONS**\$3,255,004**

\$ GRANT CAPTURE

ALL HANDS ON DECK

Department members mobilize mass COVID-testing capacity



Last January, while most of the world was still unaware of the global pandemic emerging out of China, members of the Department of Pathology were getting ready for the first wave to hit the Maritimes. No one knew exactly what to expect of the novel coronavirus, but they were 100 per cent certain of one thing—the ability to conduct large numbers of accurate tests would be crucial to keeping the virus under control in the region.

“We faced a two-fold challenge right off the top,” says Dr. Todd Hatchette, a professor in Dalhousie’s Department of Pathology and chief of the Division of Microbiology at Nova Scotia Health. “We were short on staff and short on supplies for conducting the numbers of tests we knew we would need.”

Dr. Hatchette and his team in the Microbiology Lab set to work looking for swabs, sourcing reagents,

Pictured above—Back row: Victoria Storey, Ismajl Sahiti, Lorenda Estabrooks; Front row: Alex Eddy-Stewart, Meghan Silliker



stockpiling and validating tests for the new virus, and looking for help wherever they could find it.

“It was truly a departmental response, with all hands on deck,” Dr. Hatchette remarks. “The other divisions generously allowed staff to be redeployed to the lab and trained to conduct the tests. This allowed us to ramp up our testing capacity quickly.”

Finding extra hands was not as difficult as finding swabs in the early days, when every jurisdiction in the world was competing for scarce global supplies. Intent on overcoming this obstacle, staff in the Microbiology Lab gathered supplies of the swabs used to screen for sexually transmitted infections and tested them to make sure they would be suitable for COVID.

“We were the first lab in Canada to repurpose the STI swabs,” notes Charlie Heinstein, technical manager of the lab and Dr. Hatchette’s co-lead in the laboratory’s COVID response. “Once we validated them for COVID, the rest of the country followed suit. But there were only so many of these, so we got creative and found and validated other sources of swabs. We even made our own in-house media for processing the samples, and scavenged containers that we used in homemade testing kits we assembled ourselves.” The validation of these swabs, led by Pathology Department members Dr. Jason LeBlanc and Dr. Glenn Patriquin, has been referenced by the World Health Organization in its guidance for COVID-19 testing.

Dr. LeBlanc led the laboratory staff in another innovation that dramatically accelerated the testing process, while making more efficient use of limited supplies of reagents. “We began pooling the tests, processing them in batches of four instead of doing every test one at a time,” Heinstein explains. “If all four tests are negative, we move on. If we get a positive result in a batch, we test each of the four separately.”

By the middle of the first wave, staff in the Microbiology Lab were processing 1,600 patient samples a day, compared to the lab’s typical volume of 500 to 700 samples a day. By November of 2020, the lab was able to process roughly 50,000 tests a month, with peak volumes as high as 4,000 a day.

Such a massive increase in testing capacity required not just more hands on deck, but more hours in the day. The lab’s normal operating hours of 7 a.m. to 3 p.m, Monday to Friday, were extended to 11 p.m. Not long after that, the lab began processing COVID tests 24 hours a day, seven days a week.

“We had to be quite aggressive in our procurement efforts, to ensure we had supplies for as many different testing platforms as possible,” notes Dr. Hatchette. “This way, we could nimbly shift from one platform to the next, as dictated by the constantly changing flow of supplies, to keep our levels of testing up.”

Pictured above: Charles Heinstein



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”

The lab also needed sophisticated new RNA extraction equipment to run the PCR (polymerase chain reaction) tests, which they were able to acquire with emergency funding from the federal and provincial governments. “We will receive the residual benefits of this new equipment for the next decade or more,” says Dr. Hatchette, explaining that the equipment allows the laboratory staff to extract and analyze viral RNA, so that they can identify the genetic fingerprint of the virus. This same process can be used to detect a number of different pathogens, so this new equipment will support the clinical care of Nova Scotians for many years to come.

COVID testing hits the streets

In November, when numbers suddenly ticked up again—especially among younger people who’d been visiting bars and restaurants in downtown Halifax—Dr. Hatchette semi-seriously mentioned to colleagues that he should head down to Argyle Street and run tests out of the back of his Mini. What started as something of a jest quickly turned into something very real, as he and Dr. Lisa Barrett

(cross-appointed in the Department of Pathology), along with Dr. LeBlanc and Dr. Ian Davis, also a Pathology Department member, piloted the first pop-up testing event at Halifax’s infamous nightclub, The Dome.

“We knew if we were going to put a stop to the second wave, we needed to be out testing asymptomatic individuals in a really approachable way that would make it easy and take away any social stigma people might associate with going into a testing centre to be screened,” Dr. Hatchette notes.

What started simply as proactive testing quickly morphed into a meaningful opportunity to engage with the public, as Drs. Hatchette and Barrett came up with the idea of training volunteer members of the public to administer the COVID antigen tests. Dr. Ross Davidson, a Pathology Department member well-known for his teaching abilities, trained numerous volunteers to run the rapid test at pop-up locations across the province.

Pictured above: Dr. Lisa Barrett and Dr. Todd Hatchette discuss the pop-up testing strategy.

“Pop-up testing has become an important arm of our COVID containment strategy,” Dr. Hatchette notes. “It was a big paradigm shift to use trained volunteers rather than professionals to do this work. It allowed us to expand the capacity of a strained health-care system, while also engaging with the public in a new way. We were even mentioned in Parliament for this innovative strategy.”

In the trough between waves

When the second wave settled down, efforts shifted to working with public health officials to determine the best way to approach ongoing testing of asymptomatic individuals in key sectors. Health-care workers, long-term care workers, correctional-services workers, and long-haul trucking professionals are some of the groups on the priority list for regular testing to ensure the virus is well under control.

When rates of new COVID cases were down in Nova Scotia, the team in the Microbiology Lab began pitching in to help others. “We leant a hand to P.E.I., St. Pierre & Miquelon, and even Ontario,” says Dr. Hatchette. “We have tested samples from other jurisdictions and shared excess testing supplies with other provinces and territories, especially isolated northern communities where the virus could spread and devastate a community very quickly.”

To have such low rates in Nova Scotia that the province could help others was incredibly satisfying and, as Dr. Hatchette notes, Nova Scotians are to be congratulated for following the public health

**Dr. Todd Hatchette receives
his own COVID test**

measures so well. This willingness, combined with the health-care system’s ability to conduct large numbers of tests and quickly identify and isolate cases and their contacts, have been keys to Nova Scotia’s success in controlling the virus.

“The frontline staff in the lab have done an extraordinary job,” Dr. Hatchette says. “They have been so accommodating, shifting focus and priorities on a dime to adjust to constantly changing demands within the confines of the existing systems. They stepped up in a big way, even though they were facing all the same fears and stresses as everyone else.”

As Charlie Heinsteins notes, “This experience reinforces the good work that has always been done in this lab, only now our efforts have been thrust into the spotlight for some well-deserved recognition. Our people are tired, but they are also satisfied and pleased.”



Editor's note:

With the arrival of the third wave of COVID-19 in April 2021, testing has ramped up even higher, with even more "hands on deck" to process 20,000+ tests per day some days. The Department of Pathology will continue to play a key leadership role in this crucial first line of defence against the pandemic.

GETTING TO THE ROOT

\$4.8 million project advances rapid diagnosis of rare genetic disorders



While each individual rare genetic disorder is indeed rare, taken together, the impact of these disorders is substantial. Roughly 500,000 children in Canada are affected by a rare genetic disorder—more than a third of the pediatric inpatients in the country.

“When we look at rare genetic diseases as a whole, they are far from rare,” says Dr. Jo-Ann Brock, an associate professor in the Department of Pathology and head of the Division of Pathology and Laboratory Medicine who oversees the Clinical Genomics Lab at the IWK Health Centre. “And, the

Dr. Jo-Ann Brock

consequences of many of these diseases can be profound. But some of them are treatable and by identifying them early there is an opportunity to change the course of the disease.”

Rare genetic diseases include disorders of development that result in malformation, inborn errors of metabolism, neuromuscular disorders, and many other serious issues. In general, these disorders tend to compromise metabolism of key nutrients and/or the development and function of crucial tissues including muscles, nerves, eyes, skin, heart and lungs.

National project increases local capacity

Early and accurate diagnosis of many of these disorders is about to become the new normal in the Maritimes, thanks to a nationwide Genome Canada-funded project that will accelerate the detailed DNA-analysis required. Part of Genome Canada’s “All for One” initiative, the project is increasing the local capacity for genome-wide sequencing, which includes whole-genome and whole-exome sequencing. Introducing this technology locally will allow much more timely and efficient sequencing and analysis of patients’ genetic material.

“Until now, we typically test for rare genetic disorders by analyzing individual genes of interest or small panels of genes in a sequential manner,” explains Dr. Brock, one of four local co-principal investigators on the project. “It can take a long time to go through the genes and panels sequentially, and if a causative variant is not identified, the next step may require sending samples to referral labs outside Canada for whole-exome sequencing. So this ends up taking a lot longer and costing a lot more than if we could just do the whole-exome sequencing here to start with.”

Dr. Karen Bedard
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The “exome” is composed of all the exons in the genome. Exons are the pieces of DNA that provide the codes for making proteins. Most mutations that are known to cause disease are found within the exome, so sequencing the entire exome (or, in some cases, the entire genome) is a very efficient way to search for the roots of genetic diseases. These tests, however, are not cheap, and sometimes they are not required.



“The question becomes, under what circumstances does it make more sense to go with comprehensive whole-exome or whole-genome sequencing from the start, and under what circumstances is it best to stick with single-gene sequencing?” notes co-principal investigator Dr. Karen Bedard, a molecular geneticist and associate professor in the Department of Pathology who works with Dr. Brock in the Clinical Genomics Lab.

The other two local co-principal investigators are Dr. Anthony Vandersteen and Dr. Sarah Dyack, both in the Division of Medical Genetics at the IWK. Local collaborators include Dr. Dan Gaston, Dr. Heleen Arts and Dr. Victor Martinez from the Pathology Department, Dr. Johane Robitaille from Pediatrics, Dr. Prosper Koto, a health economist from the Research Methods Unit, and Dr. Darren O'Reilly at Memorial University in Newfoundland.

Clinical study set to launch in 2021

The researchers will assess the clinical usefulness of genome-wide sequencing, compared to limited gene-panel sequencing, in a pilot group of 500 pediatric patients and 100 prenatal or neonatal patients with suspected but undiagnosed genetic disorders. Samples from these patients will be analyzed using both approaches and the results compared for clinical relevance, incidental findings and findings of uncertain significance. The genome-wide sequencing results will be analyzed in light of clinical presentation (phenotype), family history and other parameters. This data will be combined with similar data from other Canadian centres to gain a deeper understanding of the conditions in question. The project will compare the health-care utilization data from individuals

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in the study to previous patients with similar presentations to evaluate the impact of early implementation of genome-wide testing strategies.

Genome Canada provided \$1.5 million to the local arm of the project, while the remaining \$3 million was provided in part through cash donations from Dalhousie Medical Research Foundation and Research Nova Scotia, as well as in-kind donations of reagents and software licenses from vendors, and of staff and infrastructure support from the IWK.

The researchers will begin enrolling patients through the Maritime Medical Genetics Service at the IWK later this year.

“We are eager to get started,” says Dr. Brock, adding, “Children with undiagnosed genetic disorders may end up receiving ineffective medical treatment while undergoing a lengthy testing process. The more quickly and efficiently we can identify the true root of the illness, the sooner they receive the appropriate care.”

BANKING A WEALTH OF KNOWLEDGE

Pathology Department leads major expansion of tissue banks in Atlantic Canada



Atlantic Canada is now home to a comprehensive and well-funded biobanking system, thanks to the vision and diligent efforts of Pathology Department members who have championed biobanks and the development of the Atlantic Canada Biobank Consortium (ACBC) over the last several years. Rare genetic diseases include disorders of

development that result in malformation, inborn errors of metabolism, neuromuscular disorders, and many other serious issues. In general, these disorders tend to compromise metabolism of key nutrients and/or the development and function of crucial tissues including muscles, nerves, eyes, skin, heart and lungs.

Pictured above, from left to right: Drs. Manal Elnenaei, Zhaolin Xu, Sidney Croul, Thomas Arnason and Gillian Bethune

A “biobank” is a repository for donor samples of tissues and blood—often collected from cancer patients—as well as all the relevant clinical information connected to those samples. Biobanks provide researchers with access to critical information about the nature of disease and the effectiveness of treatments.

“Developing biobanks is a long-term investment in our future understanding of disease at the molecular and clinical levels,” says Dr. Zhaolin Xu, a professor in the Department of Pathology who, with thoracic surgeon Dr. Drew Bethune, spearheaded the development of Nova Scotia’s first biobank in 2005. This is a lung tissue bank that has since become Canada’s most comprehensive, with specimens and data from more than 1,250 lung cancer patients. “Having the biobanks here encourages local research, and it also allows us to collaborate with researchers around the world who want access to the specimens and data we have gathered.”



Vision of a unified biobank

Prior to 2014, there were a few individual biobanks scattered across Atlantic Canada, each operating as a separate entity. The Department of Pathology’s former head, Dr. Godfrey Heathcote, believed strongly in the importance of biobanks and felt the department should play a lead role in developing and overseeing a unified province-wide biobank. He, Dr. Bethune and Dr. Irene Sadek, current head of the Department of Pathology, secured start-up funding from the QEII Foundation to establish the NS Health/Dalhousie Biobank in 2018, with additional funding from Dalhousie Medical Research Foundation’s Molly Appeal.

Dr. Sidney Croul, medical director of the NS Health/Dalhousie Biobank, soon began mentoring colleagues in New Brunswick and Newfoundland, assisting them in setting up their own biobanks. Once the provincial banks were in place, they formed a regional consortium, the Atlantic Canada Biobank Consortium (ACBC). Together, these biobanks house tissues and data related to cancers of the central nervous system, pancreas, prostate, breast, lung, and blood, all donated by Atlantic Canadian patients.

“The ACBC has a significantly greater number and diversity of specimens than any single provincial biobank,” explains Dr. Croul. “This increases its appeal to researchers, while also streamlining researchers’ access to specimens and data.”

Consolidating all of the region’s biobanks into a single, coordinated entity also enabled the ACBC to successfully apply to the Terry Fox Research Institute’s Marathon of Hope. ACBC was awarded \$1.75 million over two years to play a lead role in the Marathon of Hope’s pan-Canadian biobanking initiative and related research studies, with the possibility of up to three more years of funding at this level. As the lead member of the ACBC, the

Dr. Sidney Croul

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NS Health/Dalhousie Biobank received \$440,000, with the option of additional funding in the future.

Understanding regional variations

As an integral part of a pan-Canadian biobank, ACBC will contribute to the growing understanding of various kinds of cancers and regional differences in the Canadian cancer landscape.

“Biospecimens provide a novel resource for the exploration of Atlantic Canada’s unique cancer biology,” notes Dr. Croul. “This is characterized by a high incidence of several cancers, such as colon, breast, lung, and brain, as well as familial cancers with unknown genetic signatures. The more we learn about these cancers and the pathways that drive them, the more we can contribute to global efforts to diagnose and treat them.”

The NS Health/Dalhousie Biobank has patients’ consent to preserve and analyze their specimens for use in future research. Without tissue preservation, this research would not be possible.

Additional biobanks for colon, ovarian and other cancers are in the works in Atlantic Canada, and, as Dr. Xu notes, the presence of biobanks is driving new research possibilities in the region. “The Marathon of Hope funding is supporting new projects in lung cancer, colorectal cancer, bioinformatics, and training and education in precision medicine, among others,” he says. “We are grateful for the increasing interest in biobanks and the funding that is allowing us to expand our capabilities and refine our processes to provide the region with a powerful resource for research and clinical care.”



A RESIDENT'S PERSPECTIVE

Dr. Farhan Khan enjoys pathology's detective work



"I think that most people who pursue pathology as a career must be detectives at heart," muses Dr. Farhan Khan, a third-year resident in the Department of Pathology's Medical Microbiology

Program. "We enjoy the hunt for the answer, 'why is this person sick?' There is so much satisfaction in finding the answer and knowing that now they can be helped."

Dr. Khan joined the Pathology Department's five-year residency training program after transferring from family medicine residency training, also through Dalhousie. He received his MD from Dalhousie in 2016, after receiving a BSc and MSc in microbiology and immunology, also from Dal.

"In family medicine, I realized how much I enjoy the diagnostic process," he says.

That's why Dr. Khan chose medical microbiology, a field in which pathologists work directly with patients in infectious diseases clinics. "These are often complex cases where we meet with the patient for an hour," he says. "This provides an opportunity for a deeper relationship with them."

Most areas of pathology do not involve direct patient contact, but play a vital role in patient health and wellbeing by providing attending physicians with crucial information.

"In one patient thought to have metastatic pancreatic cancer, we discovered it was not actually cancer... it was tuberculosis that had invaded his pancreas and gut," recounts Dr. Khan. "This finding dramatically changes his medical management and relieves him of that death sentence."

As a resident in Medical Microbiology, Dr. Khan does rotations in bacteriology, mycology, virology, parasitology, infection control, public health, and antimicrobial stewardship, among others.

"We are trying to narrow the field of possible antibiotic prescriptions to those that will truly work for that patient," explains Dr. Khan of the antimicrobial stewardship rotation. "We culture patient specimens and then test various antibiotics to see which work the best for this particular infection in this particular patient, and then advise the attending physician. The goal is twofold: to effectively treat the patient, while minimizing the

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chances of them developing an antibiotic-resistant infection by taking antibiotics that don't work."

A typical day for Dr. Khan and his Medical Microbiology resident colleagues begins with day call responsibilities at 8 a.m. "It is a great opportunity to learn the impact our work has on patient care," he says. "We receive questions from physicians about lab results and, through our conversations, we help them interpret the results in their patient's context and assist them in diagnosing and treating their patient."

Twice a day, the pathology residents do rounds through the Microbiology Lab.

"We speak with the medical laboratory technologists, to see what they are working on and if they need help with anything," says Dr. Khan, explaining that the technologists do all the day-to-day testing and reporting, while the residents and their supervisors handle the interpretation of inconsistent results and troubleshoot any difficulties. "If they are running into roadblocks, we work with them to find a solution."

Residents also attend specialty clinics and academic teaching sessions to round out their knowledge and experience. In third year, they do a longitudinal infectious diseases clinic once a week. "We see a lot of patients with rare infections," notes Dr. Khan. "It is both intensely interesting and deeply satisfying to solve these mysteries and help patients get better."

DIVISION REPORTS



Clinical Workload

8,800,000

NS HEALTH
TESTS

793,265

NS HEALTH
BLOOD
COLLECTIONS

38,000

NS HEALTH
TISSUE
COLLECTIONS



Anatomical Pathology

The Anatomical Pathology team in Central Zone includes 28 subspecialist pathologists, two fellows, 16 anatomical pathology and general pathology residents, and 75 technical and clerical management and staff members. This team provides subspecialist anatomical pathology services, including immunohistochemistry, immunofluorescence and electron microscopy, cytopathology, and autopsy pathology services to the Central Zone, as well as consultation services across the Atlantic Region and beyond.

Anatomical Pathology participates in the Department of Pathology's growing molecular laboratory. Members provide intraoperative

consultation services at the Victoria General Hospital, Halifax Infirmary and Dartmouth General Hospital sites of the QEII Health Sciences Centre.

2020 highlights include participating in the newly established Mohs service to treat patients in Nova Scotia with basal and squamous cell carcinomas. In the coming months, the team will be implementing liquid-based cytology and automated screening to improve cervical cancer screening. They will also expand their digital pathology capabilities and assist the molecular pathology laboratory team in their efforts to support personalized medicine.

The Anatomical Pathology team has a strong commitment to education at all levels. Pathologists are heavily involved in Dalhousie's Medical Sciences Program and in Dalhousie Medical School's undergraduate, graduate and postgraduate programs. Among faculty teaching

Pictured above, from left to right: Drs. Cheng Wang, Michael Carter, Saul Offman, Heidi Sapp and Ashley Stueck

highlights, Dr. Tom Arnason has received Dalhousie Medical School's Teacher of the Year award three times, while the Anatomical and General Pathology residency training programs have received strong positive reviews from the Royal College of Physicians and Surgeons of Canada.

Dr. Penny Barnes coordinates the National Resident Review Course and Dr. Martin Bullock chairs the Royal College Anatomical Pathology Specialty Committee. The Dermatopathology Fellowship Program, led by Dr. Noreen Walsh, is nationally acclaimed.

Despite its heavy clinical commitment, Anatomical Pathology excels in research. In 2019, division members published 57 peer-reviewed journal articles and three book chapters, and obtained four grants totaling \$182,200. Drs. Sidney Croul and Zhaolin Xu co-led the NS Health/Dalhousie Biobank, a member of the Atlantic Canada Biobank Consortium (ACBC). ACBC received preliminary approval for a \$2 million grant from the Terry Fox Research Institute Marathon of Hope. The lung bank, led by Dr. Zhaolin Xu and surgeon collaborator, Dr. Drew Bethune, has been active for more than 10 years, and continues to support basic science and clinical research. Pathologists in this division are widely represented on editorial boards of leading scientific journals.

Pictured below, from left to right: Drs. Martin Bullock, Joanne Murphy, Mathieu Castonguay, Gillian Bethune, Jennette Gruchy





Basic Science Research

Basic science research in the Department of Pathology is conducted by five primary or jointly appointed PhD scientists. They are keenly focused on cancer, heart disease and tumour immunology, and received \$3.4 million in basic research funding in 2020 from a number of regional, national and international agencies. These agencies include Research Nova Scotia, Dalhousie Medical Research Foundation (DMRF), Heart and Stroke Foundation of Canada, Innovacorp, the Natural Sciences and Engineering Research Council of Canada (NSERC), Canadian Institutes of Health Research, Canada Foundation for Innovation, and the U.S. National Institutes of Health. This funding led to 32 peer-reviewed publications in 2020, published in well-respected journals including *Biochem Cell Biology*, *Cell Death & Differentiation*, *Haematologica*, *Journal of Proteome Research*, *Life Science Alliance*, *Molecular Cancer Therapeutics*, *Molecular Therapy*, *Oncoimmunology*, *Science & Engineering Ethics*, *Science of the Total Environment*, and *Trends in Cancer*. The collective research outputs of Pathology's five basic scientists are highly cited, with an average H-index of 38 (range 29-50). In 2020 alone, their research was cited over 2,630 times.

The work of Pathology's basic researchers was highlighted in a number of venues throughout the year, including local, national and international media and conferences. For example, the DMRF 2020 Impact Reception highlighted Dr. Paola Marcato's latest research on breast cancer.

Meanwhile, Dr. Shashi Gujar's research on repurposing the SARS-CoV-2 virus as a next-generation cancer immunotherapy—part of an international collaboration with researchers in France, Denmark, Germany, the United States and India—was featured in major media outlets, including Fox News, CTV News and *The Toronto Star*. Dr. Graham Dellaire garnered media attention for his work in determining what mammals are susceptible to SARS-CoV-2 infection. This work sought to determine why cats (and not dogs) can get COVID-19. Stories appeared in *The Scientist* and *Fortune*, and aired on Global TV and CBC. The Dellaire group also took part in the CBC podcast SickBoy, discussing CRISPR gene editing and recent work from the Dellaire laboratory indicating that marine mammals are likely highly susceptible to the SARS-CoV-2 virus and could be infected from sewage exposure. This latter study received intense media coverage.

Pictured above, from left to right: Drs. Megan Dahn and Paola Marcato



Clinical Chemistry

In the Division of Clinical Chemistry, a small group of laboratory clinicians (3.6 medical and scientific staff) work with a large group of highly qualified medical laboratory technologists across five sites in Central Zone to provide more than six million diagnostic test results in Nova Scotia Health's Central Zone alone. The team is dedicated to providing high-quality testing, along with guidance on test selection and result interpretation.

Main clinical services:

Core Lab Services provide the bulk of routine chemistry testing and includes a totally automated platform located at the Victoria General (VG) site.

Esoteric Services include the Toxicology and Special Chemistry lab, immune-electrophoresis, and the Environmental Lab for water testing. All of these serve the province.

Out-of-province refer-out testing of more than 22,000 specialized tests, which are sent to referral laboratories after being subjected to an evidence-based vetting process.

Recent highlights include the Toxicology Section's acquisition and validation of three state-of-the-art LC-MS/MS instruments (Sciex 6500 Q-Trap), led by Dr. Bassam Nassar, to replace aging instruments used to test anti-rejection drugs (ARDs) and drugs of abuse. Two of these new instruments are now being used to improve urine drug screens, and the test menu is being expanded to include new drugs in demand by pain clinics and addiction centres. Members of the division also worked with various

Pictured above, from left to right: Drs. Bassam Nassar, Andrea Thoni, Manal Elnenaei, Amy Lou

transplant services, clinical divisions and pharmacy at the QEII Health Sciences Centre to update the relevant therapeutic ranges of the ARDs specific to various organ transplants.

Under Dr. Andrea Thoni's clinical leadership, old serum protein electrophoresis and immunofixation equipment was replaced. Her team installed and validated the new equipment, used to help diagnose plasma cell malignancies and disorders, in the midst of COVID. The next step is to trial electronic test interpretation, sign-out and patient test data storage. This will improve patient care by ensuring that patient histories and visual test results are saved electronically for easy access for years to come.

Pictured below, from left to right: Wanda Munden, Anne Gillis, Kim Spence, Dr. Andrea Thoni, Lisa White-Kerr, Tatiana Silvea

In collaboration with physicians from the Integrated Thyroid Oncology Clinic, General Pathology resident Dr. Jake Yorke and faculty members, Dr. Manal Elnenaei and Dr. Amy Lou, introduced a high-sensitive thyroglobulin test (HS-Tg) to replace the expensive and cumbersome thyrogen stimulation test (TST) used in the management of patients with differentiated thyroid cancer. This more sensitive approach to detecting early cancer recurrence will improve patient care while saving more than \$200,000 per year, which is the cost of the TST.

A new ICP-MS instrument has allowed the Environmental Services Section to expand water chemistry testing services province-wide, under the clinical leadership of Dr. Nassar, to ensure the safety of well water used by 40 per cent of Nova Scotians. The lab has also added a fluoride module to its PC-Titrate set up and continues to offer testing for clinical services such as renal dialysis.





Hematopathology

Based at the QEII Health Sciences Centre, the Division of Hematopathology provides comprehensive diagnostic and consultation services, including point-of-care testing, for all hematological disorders, blood transfusion and histocompatibility testing for solid organ and stem cell transplant patients.

The division employs 12 medical and scientific staff and four laboratory managers, who work together to oversee and coordinate diagnostic services in the largest hematology reference laboratory in Atlantic Canada, reporting nearly one million tests and dispensing 54,000 blood products annually. Hematopathology also oversees one of Canada's largest residency training programs in

this discipline and is actively involved in innovative research in areas such as blood inventory management and the development of optimized assay in transplant diagnostics and point-of-care testing.

Clinical services are distributed across eight sites in the Central Zone, organized in three main areas:

Core Lab Services provide routine hematology (CBC, CSF, other body fluid counts, malaria screening) and coagulation testing. The fully automated main core laboratory is located at the Victoria General (VG) site.

Blood Transfusion Services (BTS) performs compatibility testing (including provincial antibody investigations) and provides blood products and components for routine and emergency transfusion of inpatients and outpatients in the

Pictured above, from left to right: Drs. David Conrad, Wenda Greer and Daniel Gaston

Central Zone. BTS also provides leadership and consultations for all the provincial laboratories and the Provincial Blood Coordinating Program. This BTS is the largest east of Montreal and the first in Canada accredited by the American Association of Blood Banks (AABB).

Esoteric Services are located at the VG site and provide high-quality diagnostic hematopathology service to patients in the Central Zone. Esoteric Services are a referral site for Nova Scotia and the Atlantic provinces and provide leadership and consultation for all the provincial laboratories.

Esoteric Services are divided into five sections. Microscopy Services examines peripheral blood, body fluids and bone marrow, while the Flow Cytometry Service covers leukemia/lymphoma immunophenotyping, immunodeficiency testing, CD4 counts, and CD34 stem cell enumeration.

The Molecular Diagnostic Service provides diagnostic and prognostic testing in hematological malignancies and detection of inherited mutations in thrombosis. The Histocompatibility Laboratory Service provides full-spectrum histocompatibility testing for the purposes of solid organ and stem cell transplantation for patients/donors in Atlantic Canada. The laboratory is accredited by The American Society of Histocompatibility and Immunogenetics (ASHI) and offers a fellowship training program in histocompatibility.

Advance Coagulation Services provides comprehensive coagulation testing used in the diagnosis of bleeding disorders and thrombosis.





Microbiology

The Division of Microbiology provides diagnostic services for Central Zone and is one of the two anchor laboratories for the Provincial Public Health Laboratory Network (PPHLN), providing the bulk of reference services to the laboratories in the province.

The Microbiology Lab is directed and staffed by 60 highly qualified individuals, including a manager and secretary, three medical microbiologists, several supervisors, and more than 50 laboratory technicians and technician assistants. This dedicated team provides a comprehensive range of services, including bacteriology, mycology, parasitology, mycobacteriology, virology, serologic diagnosis of infectious diseases, and molecular diagnostics. Staff also oversee immuno-pathology serology for rheumatic diseases.

Quality patient-centred care is the lab's primary focus and staff strive for the highest possible standards in the provision of diagnostic services and in its educational and research activities.

Pictured above, from left to right: Drs. Ross Davidson, Ian Davis, Todd Hatchette, Glenn Patriquin, Jason LeBlanc

The team is committed to working with clinicians to ensure the tests they request and the service they receive are clinically relevant, and that test results are produced in a timely fashion.

The team embraces change and strives to maintain an environment where the creation of new knowledge is valued and the desire to do so is shared by all. This has been highlighted by the COVID-19 outbreak, a crisis which prompted this division to be both resourceful and determined in order to ramp up testing capacity quickly. Microbiology led the nation in innovative approaches to overcoming testing supply shortages and reaching out to the public for testing of asymptomatic individuals. It has played a pivotal role in supporting the clinical and public health management of Nova Scotia's response to the pandemic.

COVID-19 skyrocketed the volume of testing from 48,855 molecular tests in 2009-2010 to 287,928 molecular tests in 2019-2020—a 589% increase.

Even with the increased workload, faculty produced 34 peer-reviewed publications. Some addressed issues relevant to COVID-19, while others covered such topics as managing tick bites and Lyme disease in pregnancy, and the effect of frailty on recovery from respiratory illness.



IWK Department of Pathology and Laboratory Medicine

Clinical Workload

3,728,465

IWK TESTS

114,000

IWK BLOOD
COLLECTIONS

The Department of Pathology and Laboratory Medicine at the IWK Health Centre is the largest pediatric-maternal reference lab in Atlantic Canada. It employs 13 medical and scientific staff and five managers to co-lead and collaborate with health-care teams in providing state-of-the-art diagnostic services and consultation support tailored to current needs. The lab's frontline staff of 135 work as a team to deliver quality clinical service around the clock. This translates into roughly 600,000 lab tests/cases per year for patients across Atlantic Canada.

The IWK Department of Pathology and Laboratory Medicine fosters academic excellence through a strong presence in teaching and a commitment to research. Members are heavily involved in educational programs for laboratory technologists, medical students, residents and subspecialty fellows.

Pictured above, from left to right: Back row: Drs. Helene Arts, Erica Schollenberg and Zaiping Liu; Front row: Drs. Robert Fraser and Victor Martinez

IWK Divisional Activities

Anatomical Pathology focuses on pediatric surgical pathology. It also offers fetal/pediatric autopsy pathology and functions as a refer-in center for N.S., N.B., and P.E.I.

Clinical Biochemistry provides rapid, routine and specialized testing for the unique needs of IWK patients. For NICU infants, clinical chemistry works with miniscule blood volumes, reducing the number of pokes and amounts of blood needed for critical testing. Point of Care Testing (POCT) in Glucose, blood gas etc., provide rapid test results at bed site. The Division also provides maternal serum screening, biochemical genetics tests as well as some specialized tests (such as sweat test, allergy test, fecal calprotectin, etc.) for both pediatric and adult patients from the Maritime provinces.

Maritime Newborn Screening Program in IWK provides a Maritime (NS, NB and PEI) service that now includes screening for over 23 conditions and the screening panel continues to expand. In addition to testing, the MBNSP provides the entire spectrum of care – from parental counseling and healthcare provider education, to follow-up of patients and the care for those affected by these conditions. In the fiscal year of 2020/2021, there were 172 screen positives, from a total of 15655 infants. This represents 1% of the total number of infants screened by MBNSP. Our bilingual website has full information: www.maritimenewbornscreening.ca

This multidisciplinary program involves multiple divisions in Lab Medicine (Clinical Biochemistry, Clinical Genomics, Hematology, Microbiology), Pediatric subspecialists, Geneticists/Genetics Counselors, and many others who are coordinating closely with those delivering frontline care.

Hematology and Transfusion Medicine

performs both routine and urgent core hematology and pre-transfusion tests, as well as specialized testing such as hemoglobinopathy investigations for pediatric and adult patients. As the IWK is the primary pediatric oncology centre in the Maritimes, this division also collects and processes approximately 100 bone marrow samples yearly. It is the main referral site in Nova Scotia for prenatal screening and investigations of antibodies, and the sole site in Atlantic Canada with expertise for performing intrauterine transfusions.

Medical Microbiology performs expanded rapid, real-time molecular microbiology tests, including respiratory, meningitis, and enteric bacterial/viral panels. Staff focus on small-volume sample requirements and quick turnaround times.

Clinical Genomics is a full-service cytogenetic and molecular diagnostic testing facility serving the Maritimes. Cytogenetic testing is provided for a variety of constitutional studies and prenatal diagnoses, as well as for blood cancers and solid tumour studies. It is the only Maritime site accredited by the Children's Oncology Group to perform chromosome analysis on pediatric leukemia samples. Molecular testing focuses on pediatric and adult Mendelian disorders and prenatal genetic testing, using a variety of technologies.

Development of NGS (next-generation sequencing) panels for cardiomyopathies and inherited cancers, and further expansion of NGS capability, has allowed significant repatriation of previously referred-out testing, avoiding considerable cost as the demand for genetic testing grows.



New Brunswick

Clinical Workload

4,000,000

NB TESTS

2,088

NB BLOOD COLLECTIONS

The Department of Laboratory Medicine is the main laboratory at the Saint John Regional Hospital, a tertiary care centre which is the largest hospital in New Brunswick and serves the southwestern region of the province.

In-house expertise includes 10 pathologists, two hematopathologists, two medical microbiologists, a clinical chemist, a molecular geneticist and about 120 technologists and lab assistants. The services are centralized in a single location and include a full-service chemistry lab, blood bank and stem cell bank.

This lab performs four million individual tests annually, providing crucial information to busy medical and surgical specialities. The Division of Anatomical Pathology handles 20,000 surgical samples and a similar number of cytopathology specimens.

The lab also provides support to many provincial and regional programs. Provincial programs include the largest concentration of forensic pathology services, as well as the Provincial Toxicology Laboratory, which is the only publicly funded molecular pathology lab, enteric testing site and level-three mycobacteriology (TB) lab. This lab has also been identified as a partner within the consortium of Atlantic region tumour tissue banks (Atlantic Canada Biobank Consortium).

The Pathology Department also serves as a teaching site for Dalhousie Medicine New Brunswick (DMNB), providing undergraduate medical students with pathology education as well as extensive opportunities to get involved in research.

The lab also hosts residents from Dalhousie University and Memorial University of Newfoundland, as part of the Anatomical Pathology Residency Training Program. Senior residents in this program are able to do rotations in the lab that afford them an opportunity to use the skills that they have acquired during their training in a more autonomous working environment.

OUR FACULTY

Dr. Thomas Arnason
Dr. Penny Barnes
Dr. Gillian Bethune
Dr. Martin Bullock
Dr. Michael Carter
Dr. Mathieu Castonguay
Dr. Sidney Croul
Dr. Kelly Dakin Hache
Dr. Alexander Easton
Dr. Emily Filter
Dr. Laurette Geldenhuys
Dr. Jennette Gruchy
Dr. Thai Yen Ly
Dr. Jennifer Merrimen
Dr. Joanne Murphy
Dr. Shawn Murray
Dr. Saul Offman
Dr. Sylvia Pasternak
Dr. Heidi Sapp
Dr. Sorin Selegue
Dr. Ashley Stueck
Dr. Andrea Thoni
Dr. Noreen Walsh
Dr. Cheng Wang
Dr. Zhaolin Xu
Dr. Philip Moss
Dr. Lisandra Cubero Herrera
Dr. Manal Elnenaei
Dr. Amy Lou
Dr. Bassam Nassar
Dr. Calvin Cheng
Dr. David Conrad
Dr. Daniel Gaston
Dr. Wenda Greer

Dr. Robert Liwski
Dr. Jason Quinn
Dr. Mahboubah Rahmani
Dr. Irene Sadek
Dr. Allam Shawwa
Dr. Deitrich Werner
Dr. Mirette Hanna
Dr. Tish O'Reilly
Dr. Anna Greenshields
Dr. Ross Davidson
Dr. Ian Davis
Dr. David Haldane
Dr. Glenn Patriquin
Dr. Todd Hatchette
Dr. Jason LeBlanc
Dr. Lori Beach
Dr. Jo-Ann Brock
Dr. Robert Fraser
Dr. Karen Harrison
Dr. Zaiping Liu
Dr. Tim Mailman
Dr. Craig Midgen
Dr. Erica Schollenberg
Dr. Karen Bedard
Dr. Kathryn McFadden
Dr. Helene Arts
Dr. Jennifer Duncan
Dr. Jeanette Boudreau
Dr. David Hoskin
Dr. Thomas Issekutz
Dr. David Waisman
Dr. Graham Dellaire
Dr. Shashi Gujar
Dr. Paola Marcato

Dr. Behran Cenk Acar
Dr. Yu Chen
Dr. Tsetan Dolkar
Dr. Mojgan Ebrahimi
Dr. Sameh El Bailey
Dr. James Flick
Dr. Ron Francis
Dr. Tarunendu Ghose
Dr. Marek Godlewski
Dr. Mohamed Khzam
Dr. Samina Mansoor
Dr. Ather Naseemuddin
Dr. Ken Obenson
Dr. Anne O'Brien
Dr. Tarek Rahmeh
Dr. Lakshmi Rajappannair
Dr. Hasini Reddy
Dr. Yu Shi
Dr. Mehgana Toal
Dr. Ya-Gang Xie
Dr. Jaime Snowdon
Dr. Imran Umar
Dr. Mohammad Hossain
Dr. Jennifer Shea
Dr. Nancy Carson
Dr. Gregory German
Dr. Godfrey Heathcote
Dr. Dan Fontaine
Dr. Matthew Bowes
Dr. Erik Mont
Dr. Marnie Wood
Dr. Alison Edgecombe
Dr. Victor Martinez

OUR RESIDENTS

Dr. Ryan DeCoste
Dr. Alexi Surette
Dr. Valerie Taylor
Dr. Paul Zamiara
Dr. Laura Marie McDonell
Dr. Sean Rasmussen
Dr. Alexandre R. Corriveau
Dr. Priyanka Y. Ravi
Dr. Allison Maybank
Dr. Jake Yorke

Dr. Maggie Maung
Dr. Maci Ricketts
Dr. Richard Wood
Dr. Eniko Holo
Dr. Ashlyn Fong
Dr. Ibrahim Elsharawi
Dr. Tessa Boyer
Dr. Manal Al-Aufi
Dr. Buthaina Al-Maashari
Dr. Richard Xiang

Dr. Hilal Al Sidari
Dr. Ian Sarty
Dr. Yahya Shabi
Dr. Ziad Allehebi
Dr. Farhan Khan
Dr. Mariam Baghaffar
Dr. Daniel Manders
Dr. Aleksandra (Ola)
Kajetanowicz

OUR GRADUATE STUDENTS*

Hanan Aljamei (PhD)
Justin Brown (MSc)
Keon Collett (MSc)
Allyson Cook (MSc)
Sam Cutle (MSc)
Bassel Dawod (PhD)
Mike Giacomantonio (PhD)
Namit Holay (PhD)

Youra Kim (PhD)
Kateryna Kratzer (MSc)
Edwin Leong (PhD)
Mark Hanes (PhD)
Leah MacLean (PhD)
Sabateeshan Mathavarajah
(PhD)
Victoria Miller (PhD)

Mohammed Sultan (PhD)
Meg Dahn (PhD)
Carter Van Iderstine (MSc)
Lauren Westhaver (PhD)
Marie Clarie Wasson (MSc)
Vishnupriyan Kumar, (MSc)
Olivia Walker (MSc)

** These students are candidates for degrees as indicated*

OUR POSTDOCTORAL FELLOWS

Dr. Wasundara Fernando
Dr. Barry Kennedy

Dr. Vinothkumar Rajan
Dr. Meg Dahn

Dr. Megan Whaley

ANNUAL DEPARTMENT AWARD WINNERS

Janigan Teaching Award

Dr. Shashi Gujar
Dr. Saul Offman

FoM Excellence in Graduate Research Award for 2020

Dr. Meg Dahn

Wenda Greer Prize for Research Excellence

Alyson Zwicker

Pathology

Undergraduate Prize

Dr. Aleksandra Kajetanowicz

VIRTUAL RESEARCH DAY WINNERS

Best Talk by a Pathology Graduate Student

Mohammad Sultan

Best Abstract by a Pathology Graduate Student

Keon Collett

Best Abstract Judges' Choice

Meg Dahn, Hayley Walsh

Best Talk by a Pathology Resident

Sean Rasmussen

Best Abstract by a Pathology Resident

Ryan DeCoste

Graduate Student Award for Teaching, Outreach and Mentoring

Lauren Westhaver

Best Talk by an External Participant

Adam Nelson

Best Abstract by an External Participant

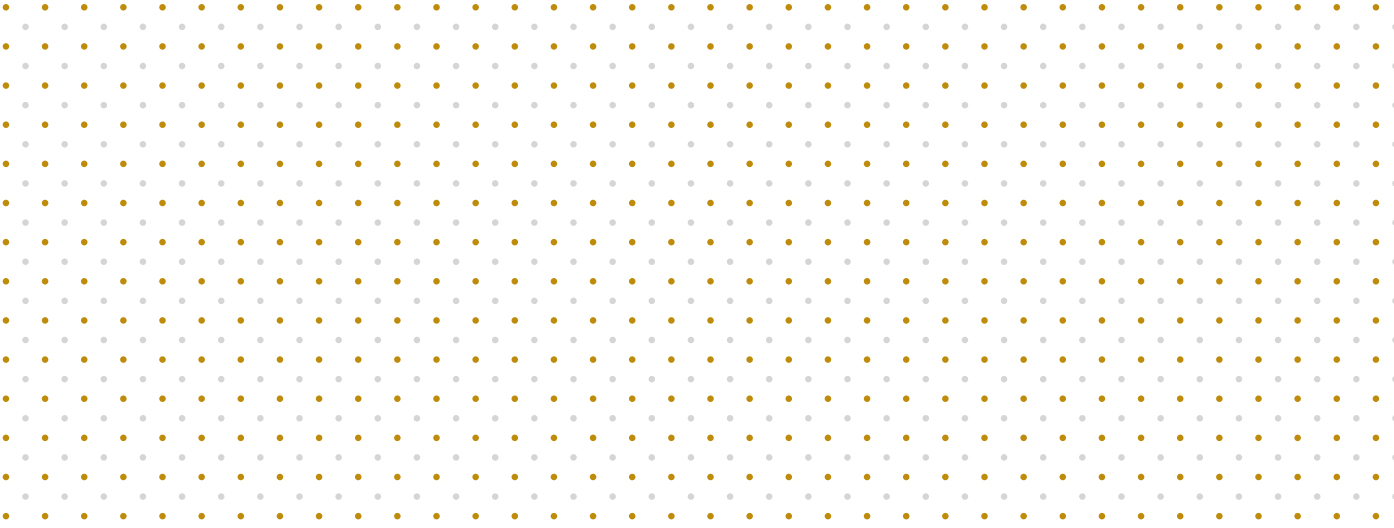
Stacey Lee

Resident Teaching Award

Maggie Maung

Gupta Travel Award

Sean Rasmussen, Priyanka Ravi
(resident award)



DEPARTMENT OF PATHOLOGY

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