# VIDO-InterVac
# Annual Report 2018–2019

University of Saskatchewan

*“Recent epidemics of high-risk pathogens demonstrate the importance of research and development as part of our global preparedness strategy.”*

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# Scientists from 26 nations working together to advance infectious disease research and vaccine development.

## VISION

Protecting Canada and the world from infectious diseases.

## MISSION

To conduct research and develop vaccines and related products with key national and international partners for the prevention and control of human and animal disease.

# Message from the Chair

Craig Vanderwagen
Chair, Board of Directors

W C VANDERWAGEN MD


The past year has been one of significant transition and expansion. At the end of last year, our director and CEO for the last eleven years (and a researcher in the organization for over three decades), Dr. Andrew Potter, retired from his position at VIDO-InterVac and transitioned to the Office of the Vice President Research as the interim associate vice president research.

Under Dr. Potter’s leadership, VIDO-InterVac’s research mission expanded and produced not only great scientific discoveries, but also several vaccine products. It was also under his guidance that our containment level 3 facility (InterVac) came into being. We will miss Dr. Potter’s perspective and insight.

In December 2018, Dr. Volker Gerdts, VIDO-InterVac’s associate director of research, was selected as the new director and CEO after an extensive international search. Dr. Gerdts has been a member of the organization for 18 years and brings both extensive institutional knowledge and a creative vision that will build on the organization’s strengths and past successes.

Dr. Gerdts has articulated an aggressive strategy for exploring and understanding zoonotic and emerging infectious diseases. Further, he is actively expanding international partnerships in both the public and private sector. We are excited to see where his leadership will take us.

Although this transition was a major undertaking this year, we have also made significant strides to advance our primary mission of researching and developing public health tools. Our containment level 3 facility is approaching full utilization which reflects the quality of the facility and the need for the high-containment research that we are able to support. This includes research targeting highly pathogenic avian influenza, Zika virus, Middle East respiratory syndrome coronavirus, and tuberculosis.

Most recently, we received approval to conduct research on African swine fever, which has devastated swine populations in Asia and represents a great risk to North America. We are the first non-government facility in Canada approved to work with this foreign animal disease.

We are also developing a vaccine manufacturing facility to fill an important innovation gap in vaccine development for the nation and the globe.

VIDO-InterVac is building on its history of high-quality research and vaccine development. We are expanding our reputation as a global asset that improves the security and well-being of both animal and human public health.

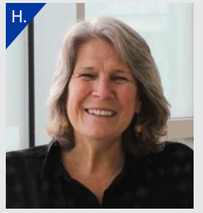
The VIDO-InterVac Board of Directors is proud to be of service and we look forward to a productive and exciting future.

# Board of Directors













- **A. REJEAN BOUCHARD** – ONTARIO
- **B. PETER BRENDERS** – ONTARIO
- **C. KAREN CHAD** – SASKATCHEWAN
- **D. AMY CRONIN** – ONTARIO
- **E. LEONARD EDWARDS** – ONTARIO
- **F. DOUGLAS FREEMAN** – SASKATCHEWAN
- **G. VOLKER GERDTS** – SASKATCHEWAN
- **H. DANYA KORDAN** – SASKATCHEWAN
- **I. CORNELIA KREPLIN** – ALBERTA
- **J. TIPPI MAK** – SINGAPORE
- **K. RORY MCALPINE** – ONTARIO
- **L. RYAN THOMPSON** – SASKATCHEWAN
- **M. CRAIG VANDERWAGEN** – USA

# Message from the Director & CEO

Volker Gerdts
Director and CEO

The past year has brought significant change to the organization. After 10 years as director of research and 11 years as director and CEO, Dr. Andrew Potter transitioned into a new role as interim associate vice-president for research at the University of Saskatchewan. Dr. Potter spent more than 30 years shaping VIDO-InterVac into the organization it is today—a global leader in infectious disease research.

As a visionary leader and dedicated mentor, Dr. Potter oversaw the development of several bacterial vaccines for livestock, including the world's first food safety vaccine for animals. Under his leadership, the organization nearly doubled in size and added one of the largest high-containment facilities in the world to enable critical work on emerging diseases and zoonotic infections. Thank you, Andy, for your immense contributions to the organization and the leadership you provided. We wish you success in your new role.

I am excited to continue on this successful path of growth and expansion. Through a set of new priorities, we will continue to strengthen our global presence, build new international partnerships, expand our scientific expertise, and focus research to enable the development of key products for our stakeholders.

"Solutions through research" describes what this organization is all about—nimbleness, teamwork, and outcome-orientated research. Developing solutions for problems faced by our stakeholders has been the organization's mandate since its inception, and we will renew this focus through a number of initiatives.

From hiring additional scientific staff to constructing a small-scale manufacturing facility to enhancing the technology-readiness level of our research, much of our focus will be on rapid development of products and technologies. This is especially important as new diseases emerge. With one of the most advanced high-containment facilities in the world, VIDO-InterVac is well positioned to quickly provide such technologies.

VIDO-InterVac's tremendous success over the last four decades is largely attributable to our enthusiastic staff and their passion for research. I look forward to working with them to continue to build a modern organization that values diversity, teamwork, and empowerment. I am thankful for the support from our internationally recognized, highly committed, and engaged Board of Directors.

As part of the "University the World Needs," we will continue to work with our many stakeholders, including the University of Saskatchewan, the Government of Canada, the Government of Saskatchewan, and the livestock and poultry industries. We are thankful for their support and commitment.

The next year will bring a lot more exciting growth, and I am honoured to be part of such an outstanding and passionate team.

> *"Solutions through research" describes what this organization is all about—nimbleness, teamwork, and outcome-orientated research."*

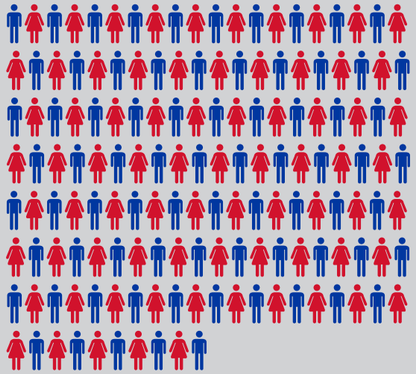
**SENIOR MANAGEMENT TEAM, FROM LEFT TO RIGHT: LORNE VANIN, RAF JAMIL, VOLKER GERDTS, CAM EWART, PAUL HODGSON.**

**Research is organized into the following programs:**

- Bacterial Vaccine Development
- Viral Vaccine Development
- Vaccine Formulation & Delivery
- Clinical Research & Animal Care
- Contract Research

MORE THAN **FOUR DECADES** OF EXPERIENCE

WE ARE LOCATED IN **SASKATCHEWAN**



**OVER 150 PERSONNEL**

# Human and Animal Health Research Highlights

VIDO-InterVac is a leader in the discovery and advancement of life-saving vaccines for humans and animals. We have commercialized eight vaccines—six of which are world firsts—and two more are in commercial development. We have also invented better adjuvants and new approaches for vaccine delivery. At a time when infectious diseases and vaccine hesitancy account for six of the World Health Organization's "ten threats to global health," these innovations are increasingly important.

The research highlights on the following pages describe the progress of our research and development. More detailed descriptions of our ongoing research and its impact can be found at vido.org.

## Preparing for Emerging Threats

Emerging infectious diseases are a top priority for our organization. Recent epidemics of high-risk pathogens demonstrate the importance of research and development as part of our global preparedness strategy. The following are three examples of our ongoing research on emerging pathogens:

### MIDDLE EAST RESPIRATORY SYNDROME

Middle East respiratory syndrome (MERS) is caused by a coronavirus that induces a severe respiratory infection that kills one in three people. Evidence suggests that the virus is primarily transmitted from camels to humans, but it is believed to have originated in insect-eating bats. Dr. Darryl Falzarano's team and his collaborators in the Middle East are working to develop a vaccine for camels to block transmission to humans. We are testing two prototype vaccines against MERS using our recently developed alpaca model in our containment level 3 facility.

The team is also trying to determine if coronaviruses can persist in insect-eating bats, how this occurs, and if these bats can infect other mammals. Currently, there are almost no other animal models that can address coronavirus persistence in asymptomatic hosts.

### THE 2020 CORONAVIRUS OUTBREAK: WE'RE ON IT

In December 2019, a new coronavirus emerged in Wuhan, China. The resulting outbreak of SARS-CoV-2 was labeled a Public Health Emergency of International Concern by the World Health Organization. Using our CL3 facility and decades of coronavirus experience, we are working with global partners to develop animal models, vaccines and other antivirals to ensure a solution for SARS-CoV-2 is found as quickly as possible. Watch for more information in our next annual report.

## INFLUENZA

The 100th anniversary of one of the most catastrophic public health events in history, the 1918 influenza pandemic (or "Spanish flu"), occurred in 2018. Emerging influenza A viruses, including those that require researchers to work in containment level 3 facilities, continue to pose a pandemic threat.

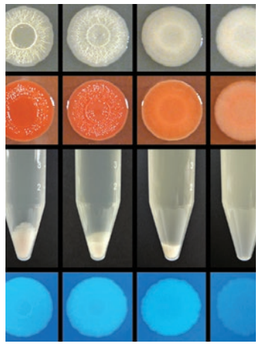
To help in the global influenza preparedness effort, we have developed mouse and ferret models to test vaccines and antivirals against several strains of influenza. As part of this research, Dr. Yan Zhou's team discovered a protein sensor that recognizes the influenza virus in the nucleus of cells—a sensor that was thought to exist only in the cytoplasm. Since Influenza A replicates in the nucleus, our researchers determined that the protein sensor helps trigger the body's antiviral immune response. This new underlying principle could be used to develop better influenza vaccines and antiviral therapeutics.

## AFRICAN SWINE FEVER

African swine fever (ASF) has spread to over 45 countries in Asia, Africa and Europe and poses a serious threat to the North American swine industry. Reports suggest millions of pigs have either died of the disease or been killed to stop the spread of the virus. Most pigs that contract ASF die within 10 days, and there is no effective vaccine or treatment for the disease.

In 2019, VIDO-InterVac became the first Canadian non-government research organization approved to work with ASF. This will facilitate the collaboration of Dr. Suresh Tikoo and his team with researchers at the University of Alberta, the Canadian Food Inspection Agency, and the South African Agricultural Research Council, and expand our worldwide efforts to develop a vaccine and test antivirals to stop this devastating virus.

# Salmonella and the Role of Biofilms



Globally, *Salmonella* causes over 153 million cases of gastroenteritis and 21 million cases of typhoid fever each year. To reduce transmission and mitigate health impacts, Dr. Aaron White and his team are studying the role of biofilms in the lifecycle of this bacteria.

Biofilms are dense collections of bacteria that stick together due to the overproduction of extracellular carbohydrates and protein polymers. Most strains of *Salmonella* that cause gastroenteritis are thought to cycle between the host and the environment using biofilms as protection. However, Dr. White's team discovered that invasive strains of *Salmonella* (like those that cause typhoid fever) have lost the ability to form biofilms due to genetic mutations. This loss suggests invasive strains have become more human-adapted and are less reliant on the environment for survival.

In addition, our researchers are developing a novel vaccine to protect against multiple *Salmonella* strains to help prevent gastroenteritis and reduce antibiotic use.



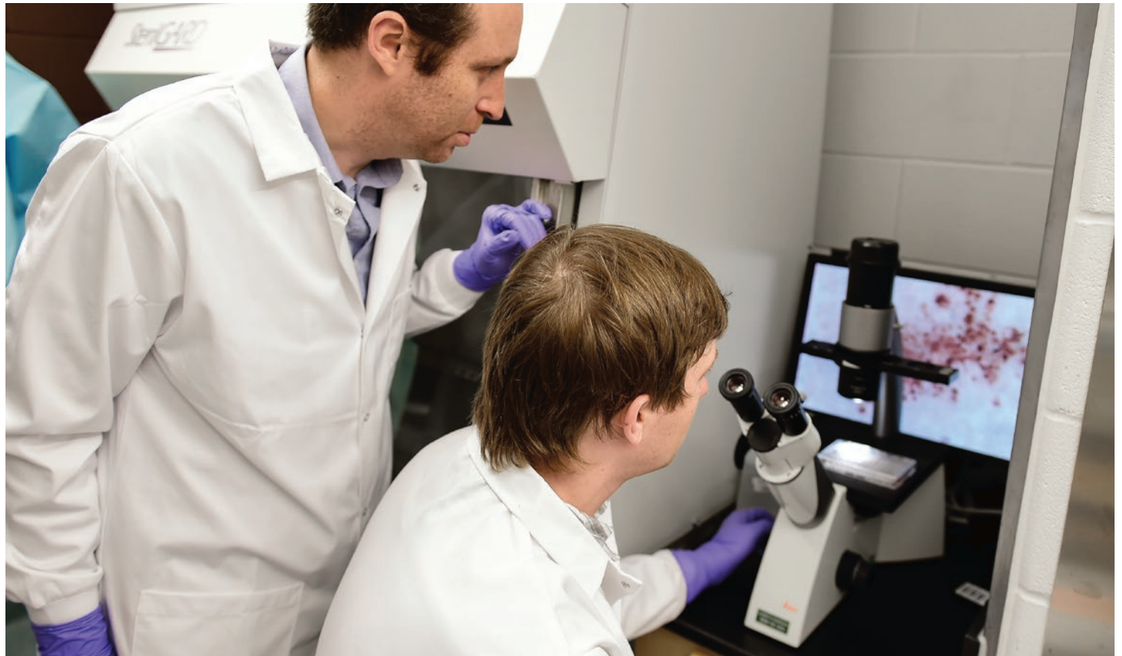
# Mild Zika Virus Infection in Fetuses May Cause Brain Abnormalities After Birth

Zika virus remains a global public health concern. It is known that infection during pregnancy can lead to fetal death or life-long developmental and cognitive impairments. However, there is growing worry that sub-clinical infection (i.e., infections showing no symptoms) in fetuses and newborns can result in neurodevelopmental disorders in offspring after birth. Currently, there are no approved vaccines or therapies available.

Dr. Uladzimir (Vladi) Karniychuk and his team worked with our clinical research group to establish a pig model to provide direct evidence to support this growing concern.

The team demonstrated that mild infection in fetuses results in abnormal brain development and impaired immunity in young pigs. This research improves our understanding of the disease in fetuses and could also point to new prevention and treatment strategies to alleviate long-term effects of Zika virus infection.

In addition, the team is using a new molecular technique to generate Zika virus vaccine candidates. This approach is also being explored to develop oncolytic viruses for the treatment of certain cancers.



# Livestock Diseases and Platform Technologies

Since our inception our organization has served Canadian livestock industries through targeted research. We are proud to work closely with swine, poultry and cattle producers to develop a range of solutions including new biosecurity practices, vaccines and innovative delivery methods. The following are examples of ongoing research:

## PORCINE EPIDEMIC DIARRHEA

Porcine epidemic diarrhea virus (PEDv) remains a significant threat to the Canadian swine industry. To improve biosecurity and stop the virus from spreading we are collaborating with the swine industry and researchers at the Prairie Agriculture Machinery Institute to improve washing and "baking" of transport trailers. In addition, Dr. Qiang Liu's team is developing a next-generation vaccine that will allow vaccinated animals to be distinguished from infected animals.

## YOLK SAC INFECTION

Yolk sac infection (YSI) is the most common reason for early chick mortality, and antibiotics are often administered to prevent and treat the disease. To meet the industry need for non-antibiotics reagents, Drs. Arshud Dar, Wolfgang Koester and Brenda Allan and their teams are identifying immune stimulants to help control yolk sac infection and strengthen the immunity of young chicks. They are also developing an *in ovo* (in the egg) platform for poultry vaccination.

## INNOVATIVE IMMUNIZATION ROUTES

Dr. Heather Wilson's team is exploring the possibility of administering swine vaccines during artificial insemination (AI)—a method that could eliminate the use of needles for vaccination. Studies have shown that a vaccine administered during AI induced strong antibody-mediated immunity and did not affect fertility and production metrics. Further safety and efficacy studies are planned.

## MYCOBACTERIAL DISEASES

Johne's disease and bovine tuberculosis are two of the most significant threats to Canadian dairy and beef producers. Using reverse vaccinology, the groups of Drs. Philip Griebel, Jeff Chen and Scott Napper are developing vaccines and companion diagnostics that differentiate between vaccinated and infected animals.



# Improving Food Security for Small-Scale African Farmers

In Sub-Saharan Africa, contagious bovine pleuropneumonia (CBPP) affects the livelihood of over 24 million cattle producers. Many of these producers are small-scale farmers, up to 50 percent of which live in poverty. The disease impacts food security, reduces trade opportunities, and increases production costs.

Disease control has been ineffective, and the live-attenuated vaccine currently on the market has safety, stability, and efficacy limitations.

As part of an ongoing collaboration with the Kenya Agricultural and Livestock Research Organization (KALRO) and the International Livestock Research Institute (ILRI), Dr. Jose Perez-Casal and his team used reverse vaccinology to develop a subunit vaccine to help prevent against CBPP. This technique analyzes the pathogen's genome to find promising vaccine candidates.

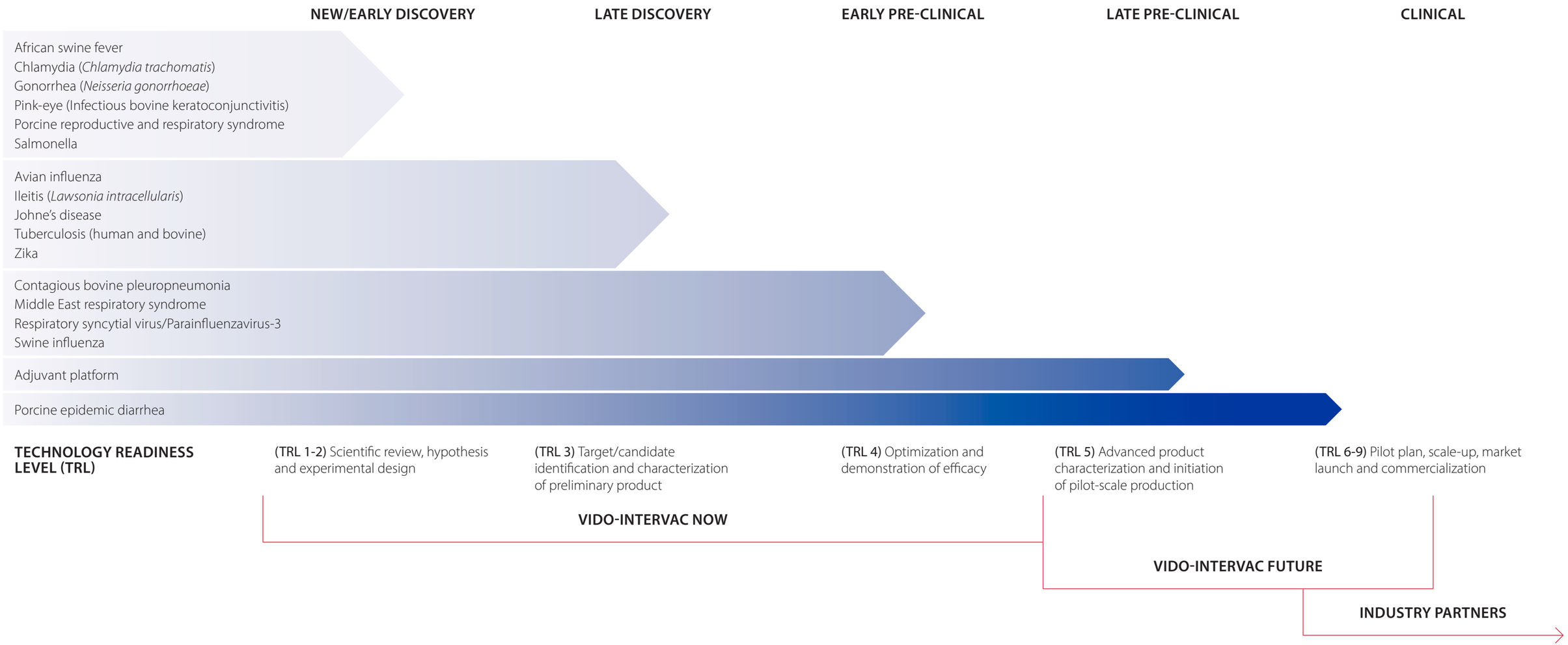
Our vaccine addresses many of the live attenuated vaccine's challenges—it's safer, less expensive to produce, temperature stable, and is expected to protect against multiple CBPP-causing bacteria. In addition, diagnostic labs will be able to use attributes of the vaccine to differentiate infected from vaccinated animals.

These advantages have earned the vaccine two awards:

- Best Veterinary Vaccine Award (Vaccine Industry Excellence Awards, 12th World Vaccine Congress)
- Science, Technology, Innovation and Collaboration Project Awards (Saskatoon Regional Economic Development Authority)

Upcoming field trials in Kenya will expand our knowledge of the vaccine's safety, efficacy, and duration of immunity.

# Vaccine Discovery Pipeline Highlights



# Dr. Andrew Potter: A Career in Reflection

In 1985 Dr. Andrew Potter joined the Veterinary Infectious Disease Organization (VIDO) as a research scientist. He was VIDO's 17th employee. What was planned as a five-year stint turned into a ~34-year tenure, ultimately leading the organization from 2007 until his retirement in 2018.

As a member of the senior management team Andy oversaw VIDO's evolution into one of the world's largest and most advanced vaccine and infectious disease research institutes. This included the expansion and rebranding of the organization as the Vaccine and Infectious Disease Organization (still VIDO) in 2003, and the expansion and initiation of containment level 3 research in our International Vaccine Centre (now VIDO-InterVac). Andy's leadership helped make Saskatchewan recognized globally for infectious disease research and vaccine development.

**DURING HIS TENURE AT VIDO-INTERVAC, ANDY MADE OUTSTANDING CONTRIBUTIONS TO VACCINE DEVELOPMENT AND THE COMMERCIALIZATION OF DISCOVERIES THAT HAVE BENEFITTED HUMAN AND ANIMAL HEALTH.**

His inventions led to 56 issued US and Canadian patents (hundreds worldwide) that formed the basis of five commercial animal vaccines, including three described as 'world firsts'. Perhaps most notably, Andy developed the world's first recombinant subunit vaccine for animals at a time when animal health

companies believed genetically engineered vaccines were unaffordable. This vaccine helped reduce the ~$1 billion annual economic loss of bovine respiratory disease, but perhaps more importantly, led to a paradigm shift—recombinant vaccines are now the industry standard. He also co-invented a cattle vaccine for E. coli O157, a bacteria that can have devastating human health outcomes from contaminated food and water. This unique perspective, vaccinating cattle to protect human health, helped him be awarded Canada's first Senior Food Safety Chair from NSERC.

Andy's scientific vision and contributions to Canada's innovation agenda resulted in numerous honors and awards including the Saskatchewan Order of Merit, the Saskatchewan Health Research Foundation Lifetime Achievement Award, and being named a Fellow of the Canadian Academy of Health Sciences. One of his most important successes has been training over 40 graduate students and post-doctoral fellows. This next generation of scientists have gone on to hold senior positions in industry, academia and government worldwide.


FROM ALL OF US AT VIDO-INTERVAC, THANK YOU, ANDY. WE WISH YOU THE BEST OF LUCK IN YOUR NEW POSITION AT THE UNIVERSITY OF SASKATCHEWAN.

CANADA'S
**LARGEST**
AND **MOST**
**ADVANCED**
CL3-AG FACILITY

OVER
**$200M**
IN CONTAINMENT
INFRASTRUCTURE

# Facility Highlights

## NEW MANUFACTURING FACILITY TO SUPPORT VACCINE DEVELOPMENT

VIDO-InterVac has some of the most advanced containment infrastructure in the world to support vaccine research and development for human and animal infectious diseases. Our facilities include:

- Containment level 2: 19 laboratories and 20 animal isolation rooms
- A 160-acre research station for large animal studies with level 2 pathogens
- Containment level 3: 8 laboratories and 18 large animal isolation rooms

Our next step in developing our facilities is establishing affordable and accessible vaccine manufacturing to fill a Canada-wide need. The shortage of this capacity is a barrier to the development and commercialization of new vaccines.

As part of the solution, the Government of Canada (through Western Economic Diversification), the Government of Saskatchewan (through Innovation Saskatchewan), and industry have invested millions of dollars to establish manufacturing capacity in our containment level 3 facility. The goal is to ensure the facility meets regulatory requirements for human and animal vaccine production, including GMP compliance.

This manufacturing facility will complement vaccine companies in Canada, and will be available to industry, academic, and government users to drive clinical development of vaccine innovations. It will also support emergency preparedness—an important step in safeguarding humans and animals from emerging and re-emerging infectious diseases.

**285,000 ft²**
OF CONTAINMENT BUILDINGS
EQUAL TO ~17 HOCKEY RINKS
OR 4.5 FOOTBALL FIELDS

# Financial Highlights

Our organization is supported by a diverse group of contributors, including the Government of Canada, the Government of Saskatchewan, international governments, the livestock industry, foundations, and human and animal health companies. (Refer to the back cover of this report for our full list of contributors.)

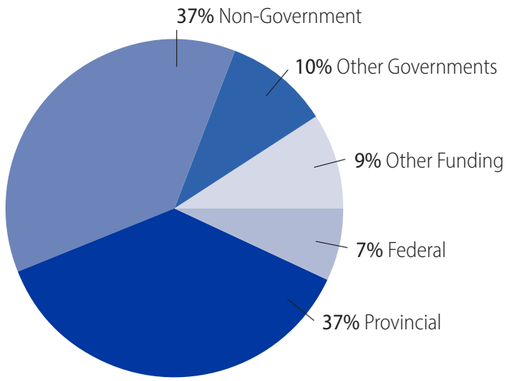
This financial support helps ensure the success of our organization and our ability to develop innovative technologies and lifesaving vaccines. Over the past year revenue increased by 11%, totaling ~$17.5 million. A primary source of this increase was the expanded operational funding for our containment level 3 facility through the Canada Foundation for Innovation's Major Science Initiatives Fund.

To remain at the forefront of science we completed infrastructure improvements and implemented strategic priorities which increased expenses to approximately $18 million. These expenses were balanced using internal resources. As we pursue strategic initiatives we are focused on the effective management of our expenses and the diversification of our funding sources to ensure ongoing sustainability.

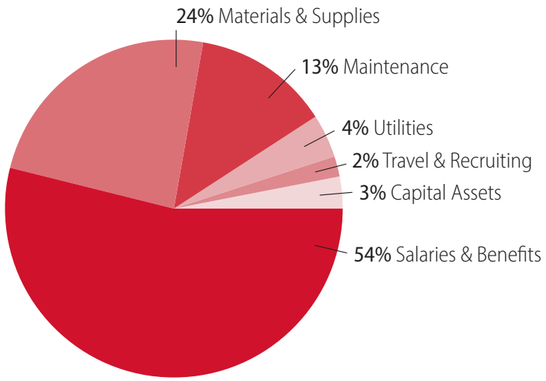
**OVER 100**
ACTIVE GRANT AND CONTRACT RESEARCH PROJECTS

**112**
U.S. AND CANADIAN PATENTS GRANTED SINCE INCEPTION

### SOURCES OF FUNDING 2018–2019




### USE OF FUNDS 2018–2019






# 2018–2019 Community Liaison Committee Report

The Community Liaison Committee is an example of best practices for containment facilities worldwide. Comprised of community leaders, the committee's role is to provide information to the public regarding safety and security at InterVac. The committee helps create and maintain an atmosphere of trust, confidence, and transparency between InterVac and the public.

While the committee has no authority over operations at InterVac, the University of Saskatchewan has given the committee a mandate to keep informed of InterVac activities that might be of public interest and to report them as appropriate.

The committee meets regularly to be briefed on the work at InterVac. This past year we received reports on three issues, two of which were minor. The most significant issue was a torn glove in a level 3 lab (no pathogen was involved and no symptoms developed). All incidents were managed to the satisfaction of the committee and there was no risk to the public.

The committee keeps informed on issues relating to infectious diseases, particularly as they apply to VIDO-InterVac. This year members shared articles on infectious diseases and pandemic preparedness. In addition, the committee received presentations on VIDO-InterVac's new manufacturing facility and toured the Command No. 9 bus—Saskatoon Emergency Measures Organization's mobile command vehicle.

To better serve the community the committee updated its website (intervacclc.ca) this year. The Community Liaison Committee also holds its public meeting every other year. The next meeting is scheduled for September 2020.

Members of the public can contact the committee at intervacclc@usask.ca.

Susan Lamb
Community Liaison Committee Chair

**2019 CLC MEMBERS FROM LEFT TO RIGHT: VOLKER GERDTS, JANICE HOBBS, NOREEN JEFFREY, SUSAN LAMB, TRACEY THUE, MORGAN HACKL AND BRIAN GIBBS. MISSING: SIMON KAPAJ, PATRICIA ROE AND DICK BATTEN.**

# VIDO-INTERVAC CONTRIBUTORS

AbCelex Technologies
Alberta Agriculture and Forestry
AMP Discovery
AnGes
Aquila Diagnostic System
Beef Cattle Research Council
Bionote
Biotech Laboratories
Boehringer Ingelheim Vetmedica
Canada Foundation for Innovation
Canadian Poultry Research Council
Chicken Farmers of Saskatchewan
Curtis Healthcare
Cytophage Technologies
Dechra
Egg Farmers of Alberta
Egg Farmers of Canada
Elanco
Eupraxia Pharmaceuticals
Genome Alberta
Genome Prairie
Government of Canada
- Canadian Institutes of Health Research
- Department of Foreign Affairs, Trade and Development
- International Development Research Centre
- Natural Sciences and Engineering Research Council
- Parks Canada
- Public Health Agency of Canada
- Social Sciences and Humanities Research Council
- Western Economic Diversification Canada

Government of Saskatchewan
- Agriculture Development Fund
- Innovation Saskatchewan
- Saskatchewan Health Research Foundation

Guangzhou Institute of Respiratory Disease
Guangzhou Yuanbo Medical Technology Company
Huvepharma
Institut Jules Bordet
Jarislowsky Chair in Biotechnology Management
Jiangsu Academy of Agricultural Sciences
Jinyu Baoling Bio-Pharmaceutical Co
Kamada
Kamloops Stockmen's Association
King Abdullah International Medical Research Center
Laval University
Manitoba Pork Council
Medicago
Merck Animal Health
Nanjing Agricultural University
National Institutes of Health
National Sanitarium Association
Phileo Lesaffre Animal Care
Proveta Nutrition
Saskatchewan Cattlemen's Association
Shandong Binzhou Animal Science and Veterinary Medicine Academy
Shandong Lvdu Bio-Sciences and Technology Company
South China Vaccine Corporation
SterileCare
The Banting Research Foundation
The Progressive Group of Companies
United States Department of Defence
United Health Biological Technology Company
University of Alberta
University of British Columbia
Vetoquinol
Zoetis



Vaccine and Infectious Disease Organization – International Vaccine Centre
120 Veterinary Road | Saskatoon, SK | Canada S7N 5E3 | **vido.org**