Enhancing high-containment laboratory preparedness against emerging bio-threats through diagnostic innovation and knowledge sharing

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Biosafety Level 4 Zoonotic Laboratory Network (BSL4ZNet)

- An international laboratory network of government-mandated organizations with national-level responsibilities to protect animal health, public health and agriculture resources.

- The BSL4ZNet supports high containment laboratory needs by enhancing scientific competency and bolstering global capacity.

BSL4ZNet Areas of Focus

INSTITUTIONAL COOPERATION

- Benchmarking survey on best practices in biosafety, operations and management
- Gap Analysis Exercise to identify challenges encountered in facilities during the COVID-19 pandemic
- Sample sharing framework and multi-lateral transfer agreement (in development)

TRAINING

- Live animal handling in high containment setting
- In person workshop on decontamination issues
- Survey of high consequence pathogens and animal models
- Inactivation Task Force Sub-Group

INTERNATIONAL RESPONSE

- BSL4ZNet COVID-19 Symposium Series
- COVID-19 Task Force
- Coronavirus Subject Matter Expertise Database

SCIENTIFIC EXCELLENCE

- BSL4ZNet International Conference
- Disease fact sheets on BSL4 pathogens (Ebola, Marburg, CCHFV, Henipa, Hendra, Lassa, Rift Valley Fever, MERS, Avian Influenza)

EMERGING PATHOGENS

- Forum to discuss pathogens of interest
- Discussions on best practices and how to respond to outbreaks

Recent Initiatives

International Conference – Forging ahead stronger: Strengthening zoonotic disease preparedness

1200 attendees from 52 countries, including co-hosting the Joint Cutting Edge Virtual Symposium on Coronavirus with 'Disease X' Potential, in collaboration with CSIRO, the USFDA and the UK International Coronavirus Network.

GAP Analysis on Pandemic Preparedness

Main areas for potential improvements:

1) Sharing Resources
2) Sharing Protocols and Best Practices
3) Strengthening of Institutional Capacity
4) Communications and Information Flow
5) Laboratory Management.

Establishment of 2 new work areas

1. Emerging Pathogens:
Best practices discussion forum for pathogens of interest such as Mpox, HPAI, ASF, Ebola virus and more.

2. Responding to Disinformation:
A forum to discuss the need for a coordinated tactical communications strategy due to growing prevalence of misinformation and increased public mistrust in science.

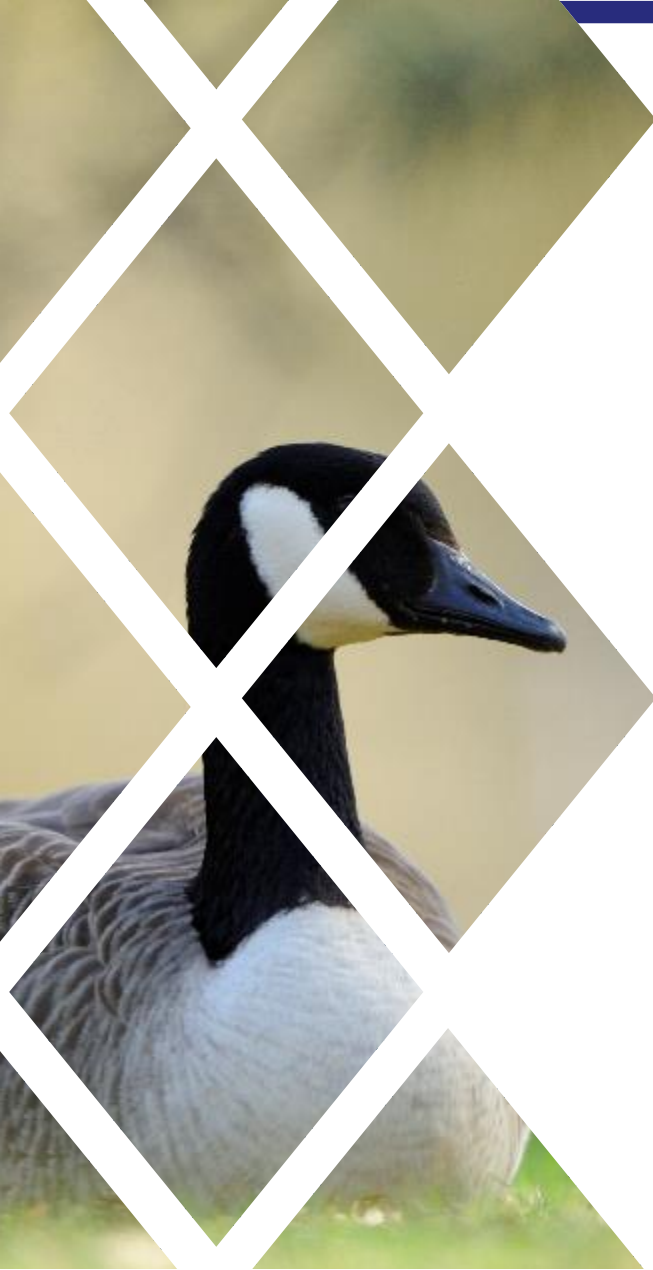# Diagnostic Innovations at the Canadian Food Inspection Agency (CFIA)

Foot and Mouth Disease

- FMDV field deployable RT-PCR; Tested for detecting virus directly in saliva in Nigeria

- Pan-serotype lateral flow device for lab and field use

African Swine Fever

- Development and validation of a field deployable molecular assay for rapid detection of African swine fever

- ASF detection in pig pens using oral fluids and use of lymph node screening in dead pigs

GLOBAL CONFERENCE ON EMERGENCY MANAGEMENT

Canadian Food Inspection Agency   Agence canadienne d'inspection des aliments

WORLD Organisation for Animal Health
Founded as OIE

Highly Pathogenic Avian Influenza

- Using genomics to identify gene re-assortments and monitor for changes in HPAI (e.g. mammalian adaptation)

- H5 assay modifications to overcome matrix assay target mismatches

Vaccine Development Approaches

- Exploring the use of H5N9 and H5N3 2.3.4.4b candidate virus vaccines (CVVs) generated by reverse genetics for DIVA applications

- Universal Newcastle disease viral (NDV) vector delivery platform for the potential to produce vaccines against multiple strains of avian influenza

- Using artificial intelligence to accurately and rapidly identify the best vaccine candidate for a FMD outbreak, based solely on gene sequences from the FMDV capsid

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Diagnostic Innovation

High Consequence Pathogen Detection

- Exploring CRISPR based diagnostics (e.g. proof of concept for detecting Crimean-Congo Haemorrhagic fever virus (CCHFV) using a CRISPR Cas13a platform

- Current efforts: Developing LAMP-Cas12b testing platform, using SARS-CoV-2 as the target

Genomics – Informed FAD Diagnostics

- Rapid, real-time high-throughput nanopore sequencing of known, novel, and unexpected pathogens

- Development of automated pipelines for processing, analysis, visualization, and reporting of short, and long-read sequencing data

- Deployment of new methods for rapidly designing whole-genome sequencing strategies for novel and emerging viruses (e.g. genome signatures and deep learning)
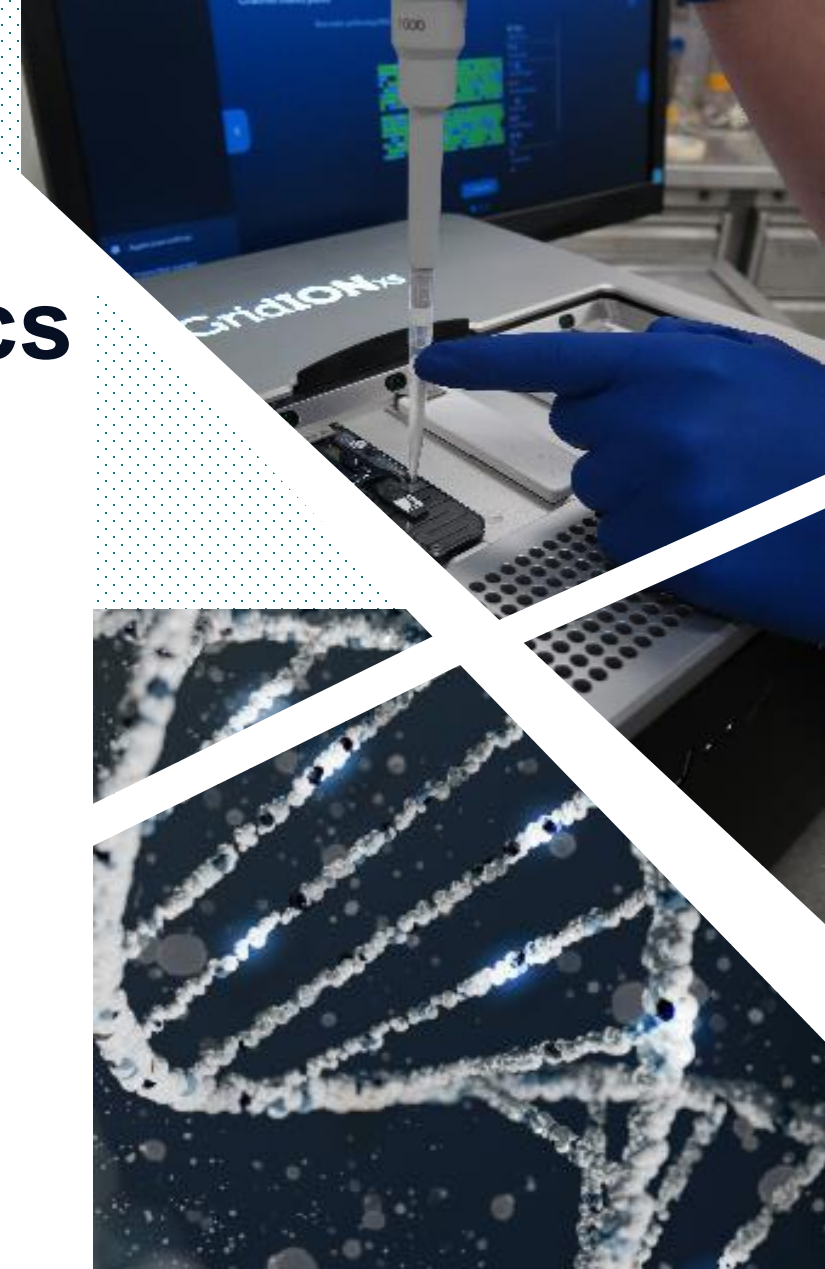
Acknowledgements

Canadian Food Inspection Agency

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Annexes

BSL4ZNet Member Organizations

Australia

Australian Centre for Disease Preparedness (ACDP)

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Canada

National Centre for Foreign Animal Disease (NCFAD), Canadian Food Inspection Agency (CFIA)

National Microbiology Laboratory (NML), Public Health Agency of Canada (PHAC)

Canadian Safety and Security Program (CSSP), Defence Research and Development Canada (DRDC)

Threat Reduction Program, Global Affairs Canada (GAC)

Germany

Novel and Emerging Infectious Diseases Laboratory, National Research Institute for Animal Health, Fredrich-Loeffler-Institute (FLI)

Centre for Biological Threats and Special Pathogens, Robert Koch Institute (RKI)

United Kingdom

The Pirbright Institute

Animal and Plant Health Agency (APHA)

United Kingdom Health Security Agency (UKHSA)

Defence Science and Technology Laboratory (DSTL), Ministry of Defence

United States

United States Department of Agriculture (USDA): Animal and Plant Health Inspection Service (APHIS) Agriculture Research Service (ARS) National Bio- and Agro- Defense Facility (NBAF)

Emerging Infectious Disease Laboratory, Centers for Disease Control and Prevention (CDC)

National Biodefense Analysis and Countermeasures Center (NBACC),

Department of Homeland Security (DHS)

CFIA Research Scientists

Dr. Aruna Ambagala

Research Scientist, Head - Mammalian Diseases Unit, Lead of WOAH Reference Laboratory for Classical Swine Fever and WOAH Reference Laboratory for African Swine Fever

Lead diagnostic and research activities on high consequence exotic and emerging viral diseases of farm animals.

Dr. Shawn Babiuk

Research Scientist, Head - Vesicular Diseases Unit

Lead diagnostic and research activities on foot and mouth disease, other vesicular diseases of domestic animals as well as capripoxviruses.

Dr. Yohannes Berhane

Research Scientist, Head of the Avian Disease Unit and World Organization for Animal Health (WOAH) Reference Center for Influenza A viruses.

Lead Diagnostic and research activities on the development, adaption and improvement of molecular and serologic diagnostic assays for exotic and emerging avian viral diseases. His research focuses on risk assessment, studying the pathogenicity, transmission and infection dynamics of emerging and novel influenza A and other emerging viruses using animal models.

Dr. Oliver Lung

Research Scientist/Head, Genomics Unit

Overseeing the High-throughput Sequencing (HTS-Illumina, Oxford Nanopore, Ion Torrent) and bioinformatics analysis activities at the Canadian Food Inspection Agency's National Centre for Foreign Animal Disease containment level 2 and 3 HTS sequencing facility.

Dr. Charles K. Nfon

Laboratory Executive Director for the CFIA's National Centres for Animal Disease (NCAD), with laboratories in Winnipeg, Manitoba and Lethbridge, Alberta.

Prior to this, Dr. Nfon was a research scientist and head of the Vesicular Diseases Unit at the National Centre for Foreign Animal Disease (NCFAD) Winnipeg. He is the head of the FMD reference laboratory for the WOAH and the Food and Agricultural Organization (FAO) of the United Nations.

Dr. Bradley Pickering

Research Scientist Special Pathogens Unit

The study of Zoonotic viruses of veterinary importance including; pathogenesis, host-virus interaction, transmission, animal models and diagnostic assay development.

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