

Research Strategy 2024-27

Centre for Pathogen Genomics



**CENTRE FOR
PATHOGEN
GENOMICS**



**Doherty
Institute**



Contents

Who We Are	2
Our Mission	2
How We Work	3
Structure and Governance	3
Funding	4
Goals of the Centre	5
Research Themes	5
Flagship Programs	6
Current Research Projects	6
Asia-Pacific Research Partners	7
Future Measures of Success	8

Who We Are

The Centre for Pathogen Genomics at the University of Melbourne (Doherty Institute) was established in 2022 as an academic and training hub to advance integrated pathogen genomics programs and create collaborative opportunities for translational research, genomics-informed regional infectious disease surveillance, capacity building and training. The Centre research team comprises of people working and interested in pathogen genomics from across the University of Melbourne, the Doherty Institute and Partners nationally and internationally. We are pathogen agnostic, and our research is focussed on using pathogen genomics to address five disciplines: Antimicrobial Resistance (AMR), Surveillance and Response, the Microbiome, One Health, and Pandemic Preparedness and Response (Figure 1). We also have significant expertise in the development and implementation of bioinformatic tools and software, machine learning, statistical genomics and phylodynamics.

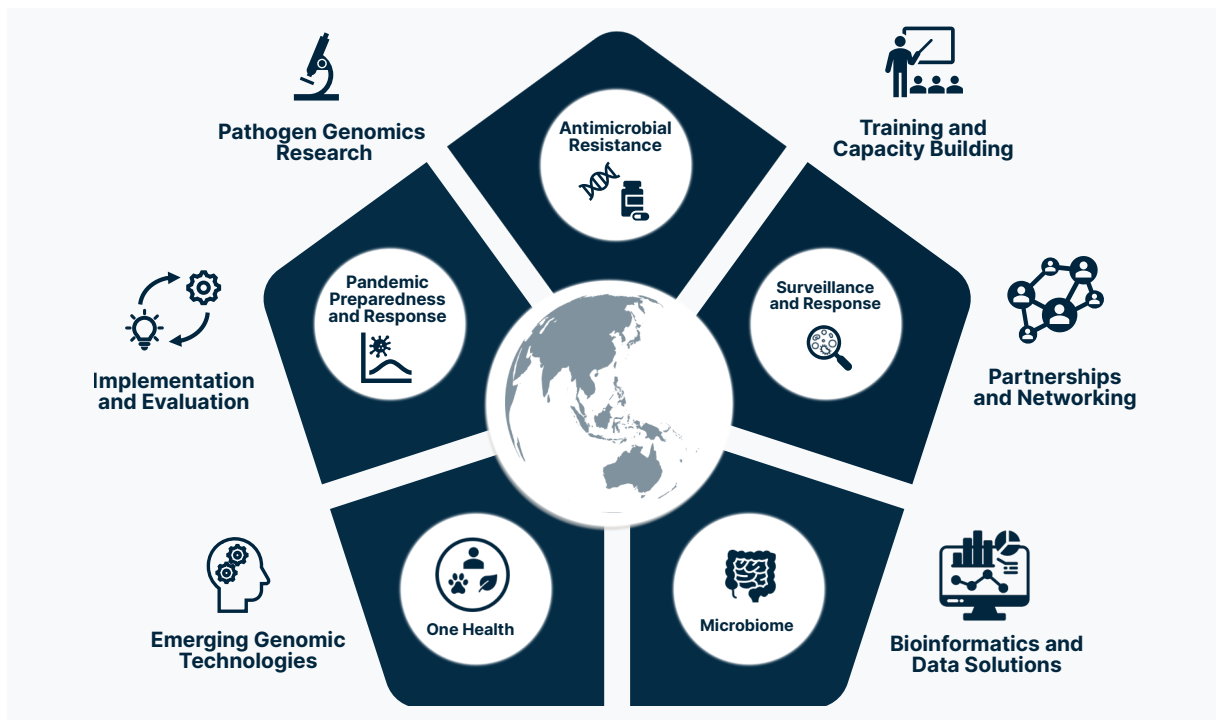


Figure 1: Our disciplines and approaches

Our Mission

Accessible pathogen genomics for better health

How We Work

The Centre is guided by principles that ensure our work is both impactful and equitable. Central to our approach is collaboration, which we see as essential for driving innovation and achieving meaningful results. We engage respectfully with Low- and Middle-Income Countries, focusing on knowledge transfer and capacity building to foster long-term, sustainable development. Our commitment to democratising access to technology ensures that cutting-edge tools and resources are available to all, irrespective of geographic or economic barriers. We also prioritise Diversity, Equity, and Inclusion, working to create an environment where varied perspectives are valued and integrated into our research.

We embrace Open Science by making our research accessible, visible, and openly shared with the global community. This supports a smooth transition from discovery research to public health implementation, bridging the gap between theoretical advancements and practical applications. These principles drive our mission to advance science in an inclusive, collaborative, and impactful manner.

Structure and Governance

The Centre is led by the Co-Directors, who are supported by the Centre Manager and the Executive Group. The Executive acts as the principal management committee of the Centre, and is responsible for the strategic direction, management, and administration of the Centre. This includes defining and delivering on the scope of the Centre across research, teaching and training, and capacity building programs, and facilitating collaboration with organisational partners. The Co-Directors are also supported by an Advisory Board comprising of key stakeholders across the University of Melbourne who can provide scientific, technical and/or strategic advice on the Centre's strategy, goals, and activities. Additionally, there is a Centre Partners Committee who provides subject matter expertise across the Centre's key scientific themes (Figure 2).

The Centre's research program is underpinned by the Research Strategy Group, which includes a diverse and multidisciplinary team of Early- to Mid-Career Researchers (EMCRs). The Innovation Hub provides Centre researchers with access to specialised genomics expertise and cutting-edge technologies, while the Bioinformatics Hub is a central resource that supports microbial genomic data analysis, by providing access to high-performance computing resources and best practice approaches for genomic data analysis, visualisation and utilisation (Figure 2). Pathogen genomics implementation across the Asia-Pacific is supported by the Teaching and Training Working Hub (Figure 2), which brings together subject matter experts across the Centre to support regional capacity building activities.

The Centre is also closely aligned with the Doherty Institute, and works collaboratively with key Themes, Cross-Cutting Disciplines and initiatives including the Doherty Computational Sciences Initiative.

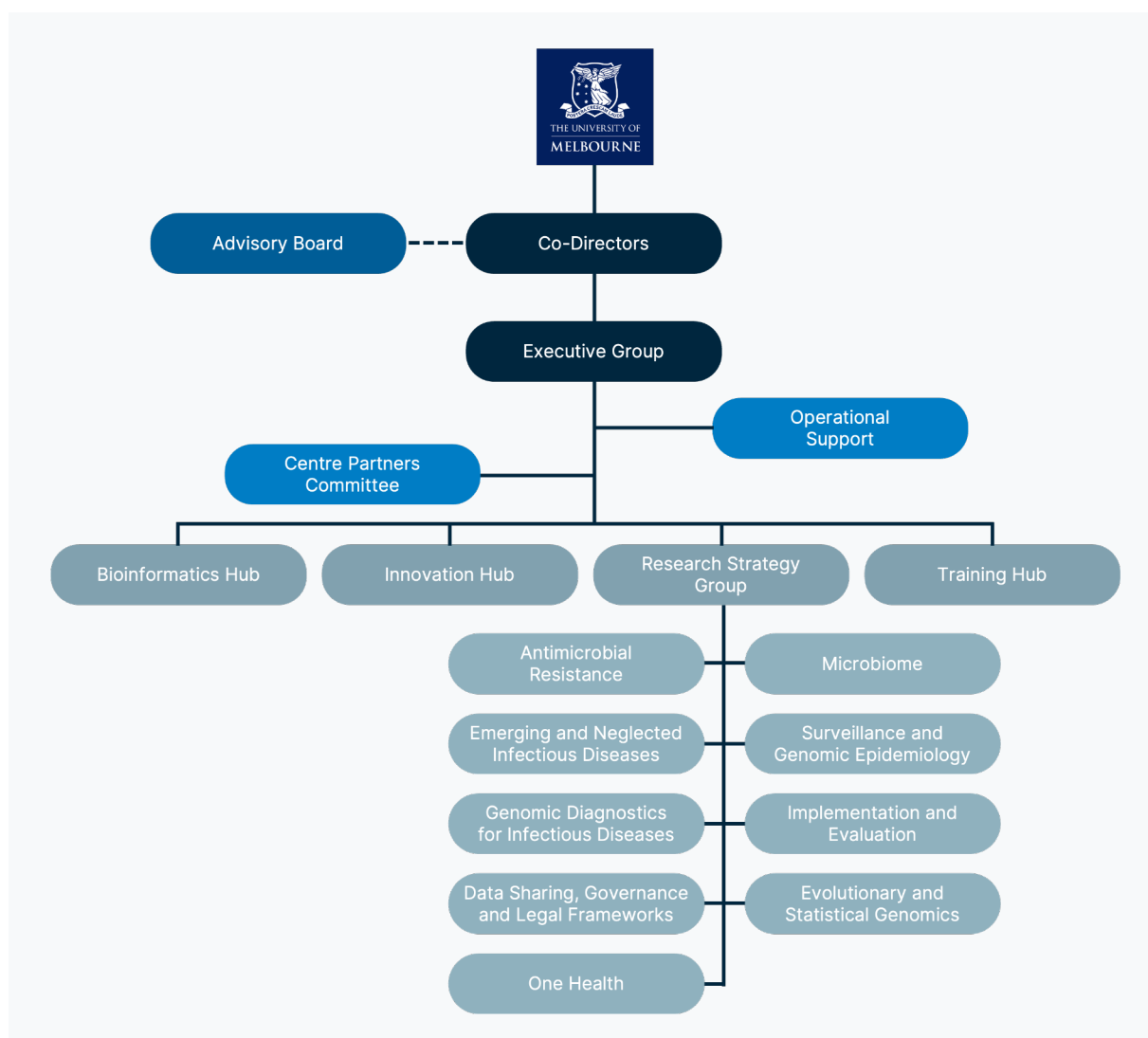


Figure 2: Centre organisational structure

Funding

Research undertaken by the Centre is currently funded by University of Melbourne and projects are funded through external funding sources including the Australian Government National Health and Medical Research Council and Medical Research Future Fund, the Chan-Zuckerberg Initiative and the Cumming Global Centre for Pandemic Therapeutics.

We are ideally placed to develop and lead grant applications underpinned by pathogen genomics, and value collaborators, including those from the Asia Pacific region, with whom we co-develop grant bids to support regionally focussed research.

Goals for the Centre

The Centre aims to be a leader in pathogen genomics research in Australia and the Asia Pacific. Specifically, we aim to:

- Undertake innovative and transformational research, from discovery to implementation, in pathogen genomics that leads to significant advancement of knowledge and improved health outcomes
- Build research capacity and excellence in Australia and the Asia-Pacific region
- Develop relationships and build networks with Institutions across the Asia-Pacific to establish a critical mass of genomics research in our region
- Link world-leading research in Australia with novel interdisciplinary, collaborative approaches to address the most challenging and significant infectious disease problems
- Provide a high-quality postgraduate and postdoctoral training environment to develop the next generation of pathogen genomics researchers
- Achieve international recognition and be global leaders in the field of pathogen genomics

Research Themes

The Centre has identified nine key research themes that encompass the program of work and overall objectives of the Centre. This provides a structure to support the implementation of the Centre's research strategy by fostering engagement and collaboration among research groups across the Doherty Institute, the University of Melbourne, and external partners in Australia and the Asia Pacific region.

The research themes of the Centre are:

- Antimicrobial resistance
- Microbiome
- Emerging and Neglected Infectious Diseases
- Surveillance and Genomic Epidemiology
- One Health
- Evolutionary and Statistical Genomics
- Genomic Diagnostics for Infectious Diseases
- Implementation and Evaluation
- Data Sharing, Governance and Legal Frameworks

Research themes are led by EMCRs within the Centre and bring together key individuals and groups through theme Special Interest Groups. The research theme leads from the Research Strategy Group (Figure 2), that supports the overall alignment across themes.

Flagship Programs



The **Metagenomics Platform (Meta-GP)** is a national multi-centre cohort study that aims to develop and implement accredited clinical metagenomics diagnostics for infectious diseases in Australian clinical and Public Health Laboratories. This collaborative program will bring together Australia's leading researchers in pathogen genomics and clinical infectious diseases to create a nationally accessible network of laboratories that can apply metagenomic approaches in patient care to rapidly detect, prevent, and respond to infectious threats, including antimicrobial resistance.



The Australian Pathogen Genomics Program (AusPathoGen) is a large scale integrated public health pathogen genomics research program, that will demonstrate the utility, cost-effectiveness, and capacity for translation of genomics into public health nationally. The program will deploy the national genomic platform (AusTrakka), for consistent analysis and reporting, and will collaborate with health departments and public health laboratories to implement national genomics-based responses to major infectious disease threats.

Current Research Projects

Customisable Biotherapeutics Against Pandemic Pathogens. The development of adaptable, “pathogen agnostic” interventions capable of combating a wide range of pathogens is an essential element of pandemic preparedness. The microbiome plays a crucial role in lung immunity via the gut-lung axis, and therapeutics that modulate or restore this axis offer a promising approach for combatting pandemic pathogens. This project will establish a human gut microbiome biobank and utilise advanced multi-omics and computational approaches to identify microorganisms that will serve as biotherapeutics, restoring a healthy gut-lung axis, enhancing immunity, and providing tailored solutions to address future pandemic threats.

Elimination of *Mycobacterium ulcerans* infection. Buruli ulcer is a neglected tropical skin infection caused by the bacterium *Mycobacterium ulcerans*. Research conducted over the past 20 years has established that mosquitoes transmit the infection in Australia. This project aims to track the pathogen in the environment and work toward eliminating Buruli ulcer by treating infections in Australian native possums and implementing innovative mosquito control measures. Additionally, the study will investigate vaccine development to prevent Buruli ulcer in humans.

Cryptosporidium Genomics. *Cryptosporidium* is among the leading causes of diarrhoeal disease globally, with numerous human outbreaks linked to waterborne and zoonotic transmission. Due to a lack of specific treatment options, the best defence against *Cryptosporidium* infection is prevention and control. However, in Australia human, animal and environmental surveillance is siloed making it difficult to track and understand *Cryptosporidium* outbreaks. To address this, we will establish a One Health *Cryptosporidium* Surveillance Network to enable accurate and timely detection of animal, environmental and human cases, and inform implementation of evidence-based interventions and policies to prevent and reduce disease outbreaks.

Harnessing the gut microbiome to fight multidrug- resistant organisms. Colonisation of the human gut by multi-drug resistant organisms (MDROs) is a significant public health problem, especially in healthcare settings where infections are challenging to control due to limited treatment options. Recent studies have shown that Faecal Microbiota Transplants (FMTs) may help to suppress MDRO growth in the gut. However, to integrate FMT into routine clinical practice in Australia, we need a precise understanding of the FMT components that can be used for treatment, and a standardised approach to assess patient outcomes. Through metagenomic sequencing, advanced statistical analysis, and screening of extensive FMT biobanks, this project will identify microbiome features associated with resistance to MDRO colonisation and optimise FMT protocols for effective clinical implementation, providing a novel treatment option for patients with limited therapeutic options.

Genomic epidemiology of *Salmonella typhi* in the Western Pacific Region. Typhoid fever, caused by *Salmonella Typhi*, remains a significant public health threat in Pacific Island countries, with the emergence antimicrobial resistance (AMR) complicating effective treatment and control of *S. Typhi* infection. This project will conduct comprehensive genomic and epidemiological surveillance of *S. Typhi* in Pacific Island countries, and evaluate the evolution of disease patterns and *S. Typhi* strains across the region before and after the introduction of typhoid conjugate vaccines (TCVs). By employing advanced molecular characterisation and antimicrobial susceptibility testing, this research will provide crucial insights into the genetic diversity of *S. Typhi*, assess the effectiveness of TCVs in preventing breakthrough infections, and inform targeted public health interventions. Ultimately, this project will contribute to improved typhoid fever control strategies and combat the spread of AMR in the Western Pacific Region.

Avian influenza ecology, evolution and impacts. Avian influenza poses a significant threat to wildlife, domestic animals, and human health worldwide. While Australia remains free from highly pathogenic avian influenza (HPAI) H5N1, understanding the ecology and evolution of low pathogenicity avian influenza (LPAI) is crucial for maintaining biosecurity. This project will employ cutting-edge pathogen genomics to track LPAI incursions into Australia via migratory birds and map its spread across the continent. By analysing viral diffusion patterns and evolutionary dynamics, we aim to predict potential HPAI emergence and inform targeted surveillance strategies. This project will also investigate HPAI impacts in Antarctica, contributing to a comprehensive understanding of avian influenza's global reach. Collectively, these efforts will enhance early warning systems and guide evidence-based policies for mitigating the OneHealth risks associated with avian influenza.

Asia-Pacific Research Partners

The Centre has established partnerships across Australia and the Asia-Pacific region that enhance the scope and impact of our work (Figure 3).

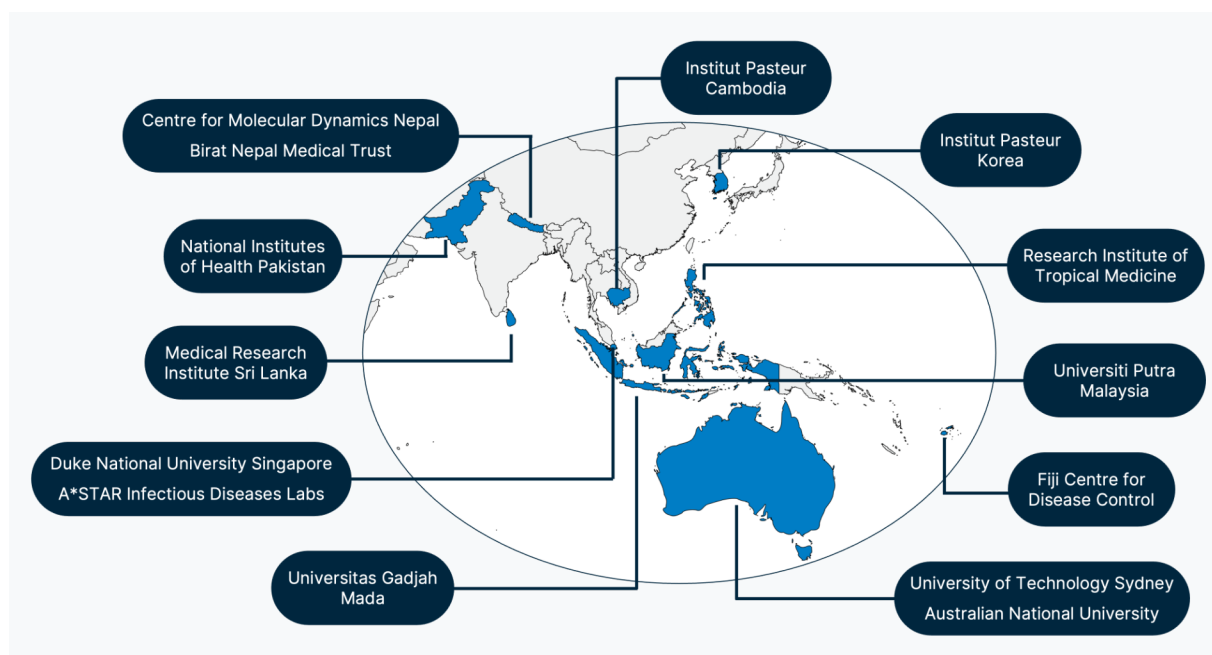


Figure 3: Key Centre Partners across Australia and the Asia-Pacific region

The Centre also fosters new partnerships through:

- Organisation and participation in collaborative meetings to identify areas of mutual interest
- Contributing to the development of research projects and identification of funding for projects
- Identification and development of joint training opportunities (e.g. joint PhD candidates, interdisciplinary training opportunities for EMCRs)
- Support for access to and use of cutting-edge genomic technologies

Measures of Success

We are committed to objectively measuring our performance and impact in the following way:

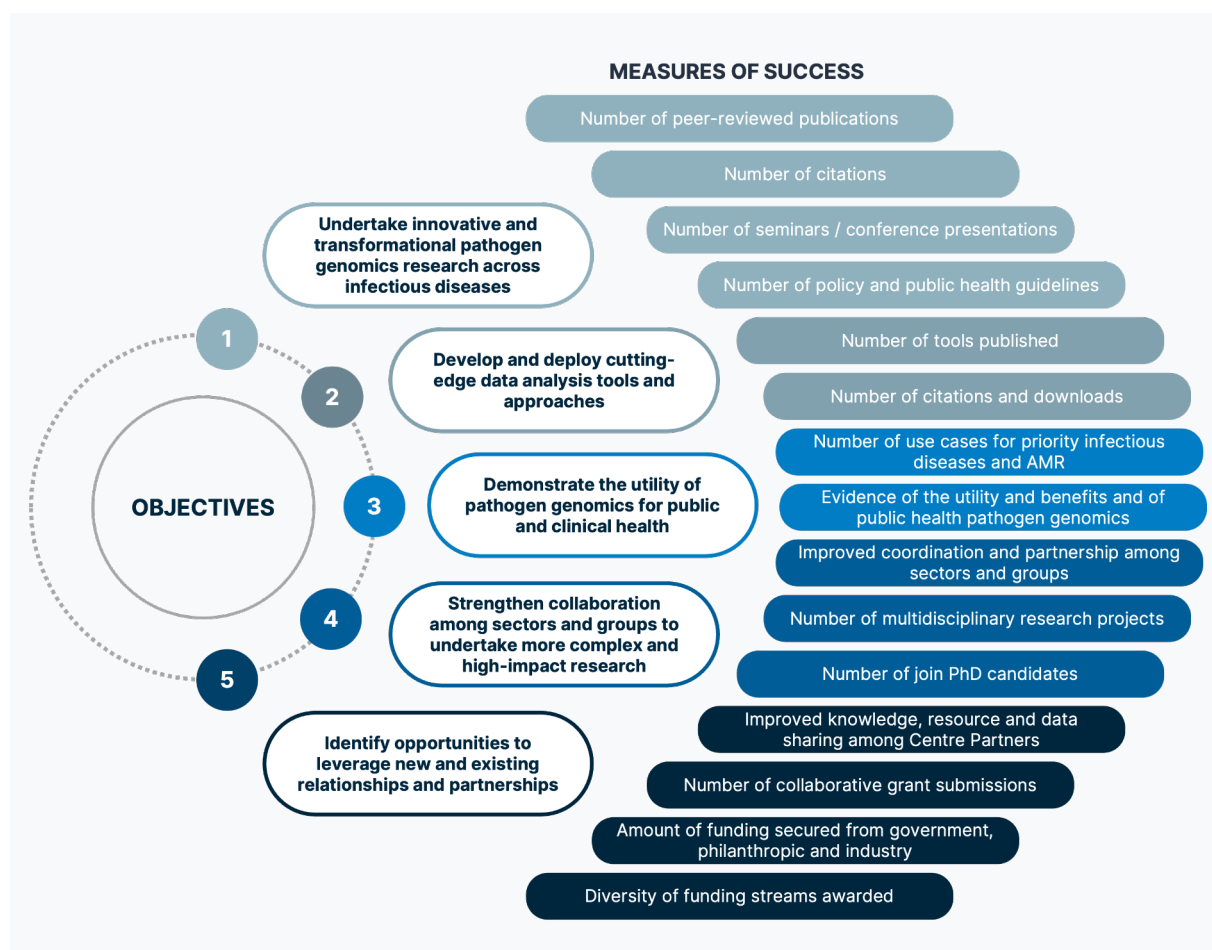


Figure 4: Measures of success



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