



Research Platform 06

# Vaccines and immunology

## Defining vaccines and immunology

Immunology is the study of the immune system, which encompasses our bodies' natural response to invading pathogens like bacteria and viruses, as well as to cancer. By understanding how the immune system works, we can better respond to infectious diseases like influenza or HIV and non-communicable diseases like cancer. One of our main lines of defense against many diseases is vaccines, which prepare the immune system to be ready to respond if it is infected by the live pathogen. Immunology can also help us understand what happens when the immune system wrongly targets healthy cells, like what happens in autoimmune disorders like multiple sclerosis or type 1 diabetes.

The Melbourne Biomedical Precinct has a long history of leadership in immunology. Melbourne Biomedical Precinct researchers are developing new vaccines and therapies to prevent, treat and cure diseases that affect Australians, along with hundreds of millions of people across the globe.

Recent outbreaks of Ebola, Zika, H1N1 influenza and SARS serve as potent reminders of the ever-present threat of infectious diseases, as well as the devastating health and economic impacts they can have here and across the globe. For example, the 2014 Ebola outbreak caused over 11,000 deaths, with the global response costing over \$4.7 billion. A year later, the Zika virus emerged in Brazil and spread throughout South America and then around the world, with an estimated social and economic impact of \$23.6 billion.

Even seasonal influenza can be life-threatening, resulting in over 1,400 deaths in Australia each year, along with 300,000 GP consultations and 18,000 hospital admissions. The sudden

appearances of SARS in 2002, H1N1 swine flu in 2009 and Middle East Respiratory Syndrome (MERS) in 2012 also remind us that new viruses can emerge at any time and can easily spread to Australia unless they're responded to rapidly and effectively.

Key to responding to these threats is a better understanding of our immune system, which can lead to the development of new vaccines to prevent infections. Research is underway in the Melbourne Biomedical Precinct to develop vaccines targeting diseases like malaria, HIV, rotavirus and Group A streptococcal which infect millions of people worldwide. Effective vaccines would save lives and also reduce the burden of these diseases, particularly on developing countries around the world. Also under development is a one-shot vaccine that targets influenza, which would eliminate the need for annual injections.

Another crucial component to combating infectious diseases is monitoring outbreaks, tracking their spread, coordinating responses and developing new preventative strategies. Given many diseases originate overseas, greater engagement with other organisations and governments around the Asia-Pacific region will enable Australia to respond effectively in the event of another major disease outbreak.

An alarming development is the rise of 'superbugs' that are developing resistance to our most potent antibiotics. For example, over 480,000 people develop multi-drug-resistant tuberculosis alone each year and Australian patients are increasingly at risk from infection by drug-resistant bacteria in hospitals. Melbourne Biomedical Precinct researchers are recognised leaders in understanding bacteria and why they can become resistant to antibiotics, developing new techniques to identify microbes that are developing drug resistance. Melbourne Biomedical Precinct researchers are also investigating new drugs that can kill off microbes or render them harmless.

A better understanding of the immune system is also helping us develop breakthrough immunotherapy treatments, which effectively co-opt the immune system to combat diseases such as cancer. Multiple drugs that boost the immune system have now been licensed and have shown remarkable effectiveness in some cancers. With continued development, it is anticipated that cancer may become an easily treatable condition.

## Current strengths and opportunities

### Global alliances

The Melbourne Biomedical Precinct has strong existing partnerships with global health institutions, including the World Health Organisation (WHO), Bill & Melinda Gates Foundation, the National Institutes of Health and the Wellcome Trust; for example the project to develop a vaccine for rotavirus (funded by the Bill & Melinda Gates Foundation).

### Regional focus

The only WHO Collaborating Centre for Reference and Research on Influenza in the southern hemisphere is based in the Melbourne Biomedical Precinct at the Doherty Institute.

### History and collaboration

The Melbourne Biomedical Precinct has a long history of leadership in immunology. There is extensive collaboration with local organisations on immunology and vaccines, including with CSL and the CSIRO.

### From lab to bedside

The Melbourne Biomedical Precinct contains a breadth of research expertise from basic science through to clinical practice and world-class hospitals. This makes it an ideal location for conducting clinical trials of new vaccines and drugs, including in areas such as oral disease and diabetes.

## Future opportunities

### Asia-Pacific regional leadership

The next major infectious disease outbreak is likely to emerge in the Asia-Pacific region and is almost certain to spread to Australia. The Melbourne Biomedical Precinct's expertise in research, diagnostics, clinical care, drug development and commercialisation, as well as best practice when it comes to dealing with an infectious disease outbreak, makes it ideally situated to take a leadership role in the Asia Pacific region in responding to infectious diseases.

### Tackling antimicrobial resistance (AMR)

Overuse of antibiotics is increasing the prevalence and ongoing transmission of AMR, posing a major threat to health care. The Melbourne Biomedical Precinct has expertise in rapid sequencing of microbes so an outbreak can be stopped quickly, as well as in developing novel strategies to minimise antibiotic use and developing treatment drugs. The Melbourne Biomedical Precinct is home to The University of Melbourne's Faculty of Veterinary and Agricultural Science, allowing for programs that can stop transmission of antibiotic resistant organisms from animals to humans. This expertise will increasingly rely on genomic sequencing of microbial organisms that will lead to more precise treatments for patients and eventually new antimicrobial drugs. The use of electronic medical records in hospitals will also help identify behaviour changes in clinicians and patients in relation to the overuse of antibiotics.