Science

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£3.4million shot in the arm for AI-enabled vaccine technology

University of Cambridge researchers have been awarded £3.4million in grant funding from the government to develop artificial intelligence-enabled vaccine technology that will help protect against viruses that could spread between animals and humans, *writes editor Paul Brackley*.

They will use AI to analyse decades of viral data and design flexible, 'plug-and-play' vaccine components that offer broader protection against multiple strains before they can cause major outbreaks.

Professor Jonathan Heeney and his team in the Laboratory of Viral Zoonotics at the Department of Veterinary Medicine will lead the three-year project alongside colleagues Professor Dan Tucker, Dr Sneha Vishwanath, and Dr Daniel Storisteanu, in a joint effort with the Animal and Plant Health Agency (APHA) and the Cambridge spin-out company DIOSynVax.

Traditional animal vaccines are created using older versions of a virus, meaning they work well against known strains but can fail when a mutated virus emerges.

By contrast, the new technology will be capable of rapidly generating vaccine antigens against emerging animal and zoonotic disease threats. Rather than forcing scientists to start each time from scratch, this will create adaptable vaccine platforms that can be rapidly deployed against emerging pathogens affecting livestock, wildlife and humans.

The aim is to improve outbreak preparedness and bolster national and global biosecurity.

Co-funded by UK Research and Innovation (UKRI) and the Department for the Environment, Food and Rural Affairs, the grant is part of a £54million national investment across 18 projects aimed at tackling future disease outbreaks, protecting food supplies, and curbing antimicrobial resistance.

It comes as a study from Prof Heeney's team, DioSynVax and APHA, published in the *Journal of Virology*, demonstrates how this works in practice. It explains how a computationally-designed flu vaccine protected pigs not only against a target strain of influenza, but against a wide range of different human and swine flu viruses.

Pigs can catch bird, pig and human flu at the same time, making them a significant source of flu viruses and giving different strains a chance to mix and create dangerous new variants, as seen in the 2009 swine flu pandemic.

Prof Jonathan Heeney at the Laboratory of Viral Zoonotics Picture: Keith Heppell

Prof Heeney, professor of research in vaccinology at Cambridge and the founder of DIOSynVax, said: "Many of the greatest infectious disease threats facing humanity emerge when and where animals and humans closely interact.

"Our newly-published influenza study demonstrates that computationally-designed vaccine antigens can provide broad protection against viruses circulating in both humans and animals.

"Combined with this important new UKRI and government investment, we have an opportunity to accelerate development of adaptable vaccine technologies that can help protect animal and thus human health, strengthen food security, and develop improved, broadly protective vaccines to prepare and hopefully contain, control and prevent future epidemics and pandemics.

"Artificial intelligence is transforming our ability to anticipate viral evolution and design vaccines proactively rather than reactively. Our goal is to create broadly protective vaccine antigens that can be plugged into different animal and human vaccine platforms and therefore enable a much faster, more effective response to emerging biological threats while advancing the UK's leadership in biosecurity innovation."

The team created synthetic influenza antigens that were optimised from large-scale viral sequence datasets, representing decades of influenza evolution.

The vaccine significantly reduced viral shedding following infection with a swine-origin H1N1 virus and performed comparably to a conventional strain-matched vaccine. But it also provided heterologous protection and much broader immune recognition across human and swine influenza strains.

Researchers at the Department of Veterinary Medicine are also contributing to another project funded by the £54m investment, aimed at finding practical ways to reduce antibiotic use in UK farming.

It is part of the work of the AMAST (Antimicrobial Resistance in Agrifood Systems Transdisciplinary) Network, which brings together 13 research organisations alongside farmers, vets, and government partners. Their aim is to focus on swine and cattle health while keeping medicines effective for the future.

Prof Tucker, professor of veterinary public health, said: "It is wonderful to see Cambridge's Department of Veterinary Medicine represented on more than one of these projects – allowing us to contribute our combined strengths in vaccine design, livestock infectious diseases, and antimicrobial resistance research.

"Our vet school has a long history of infectious disease and One Health research that make real differences to livestock health and welfare, farmers' livelihoods and ultimately society."

Prof Nick Bexfield and Prof Caroline Trotter, joint interim heads of the Department of Veterinary Medicine, said: "We are delighted by this news, which highlights the incredible quality and diversity of work taking place across our department. Warmest congratulations to everyone involved in driving this vital research forward."

The work comes after a government report highlighting advances at the intersection of artificial intelligence and life sciences praised work at the University of Cambridge.

It noted: "Earlier this year, a team at the University of Cambridge developed the first entirely AI-designed vaccine – designed to provide broad-spectrum protection against entire viral families – provisionally coronaviruses, but also universal vaccines for influenza (whether pandemic, zoonotic, or seasonal) and viral haemorrhagic fevers (including Ebola) – even those that have mutated."

Droplet LEGO work earns ARIA support

'Droplet Lego' research at the University of Cambridge, which uses proteins like tiny Lego bricks, has been awarded funding from the Advanced Research + Invention Agency (ARIA).

Prof Ronan Daly, from Cambridge's Institute for Manufacturing, leads the 'Protein SPARK' project, which aims to use proteins to grow magnets without rare-earth elements and advanced electrodes for batteries that hold more charge and last longer. It is inspired by the way proteins direct biomineralisation – the process by which living organisms build hard materials such as bones and teeth.

The researchers aim to use this approach on a continuous production line. Microscopic droplets carrying the designed proteins and elements will be sprayed and printed into position, like in inkjet printing.

The proteins grow, guide and shape the constituent material into nanocrystals, films and three-dimensional structures, which provides the team with control over the shape and the function as the material forms.

"Magnets are all around us, from headphones and mobile phones to motors and wind turbines," said Prof Daly. "Almost all magnets include rare-earth materials, which are costly to extract, are a diminishing resource and lead to significant environmental challenges. Our project, which is at its heart a manufacturing project, will instead use proteins to drive growth of useful magnetic materials without using rare earth materials anywhere. We will then look at how to apply this to other products, like new batteries that charge quickly and last longer."

They have been given a share of funding from ARIA's Universal Fabricators Programme, a three-year, £50million programme that will support 11 research teams, focused on the idea that proteins can act as a 'universal fabricator'.

Cambridge researchers are also working on two other projects. One aims to make high-performance magnets by using specially designed proteins to control how magnetic crystals grow and arrange themselves.

Another aims to develop new materials by combining naturally self-assembling proteins with metals.