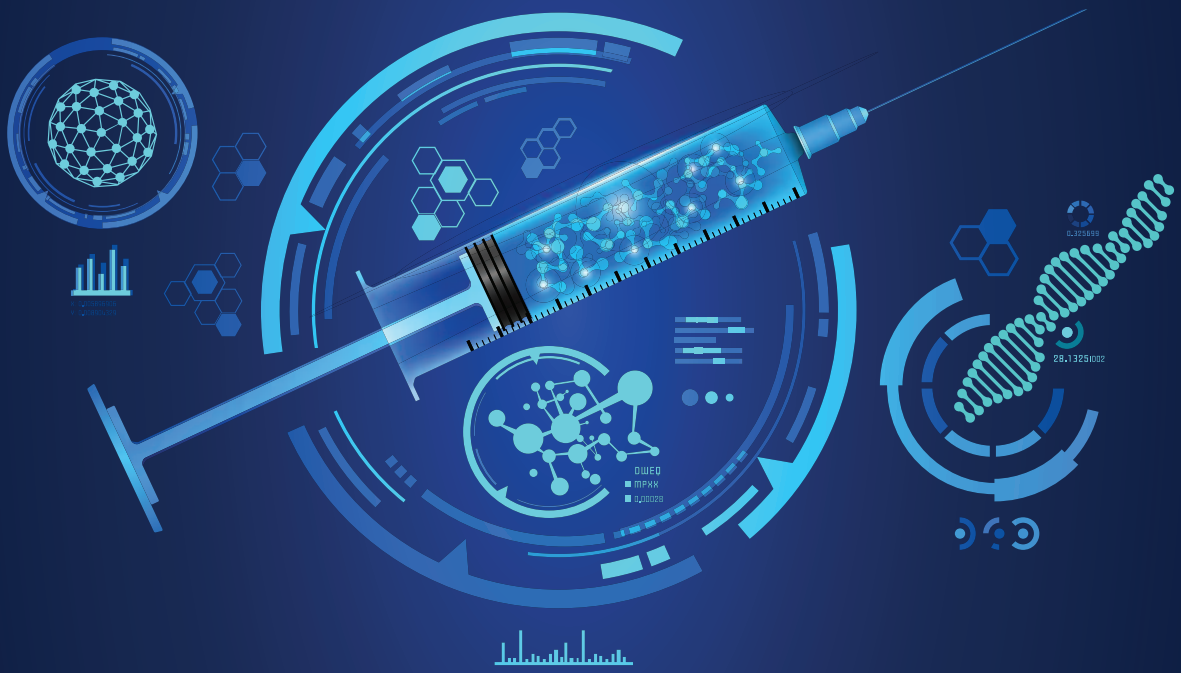
Next-generation vaccine design

A novel vaccination strategy targeting DNA sensors to overcome deficit in cellular immunity in neonatal calves was the winner of the 2017 TEAGASC invention of the year awards.



The Teagasc invention of the year awards, as part of the annual Bridge Network consortium commercialisation awards (comprising the technology transfer offices (TTOs) of Teagasc, University College Cork, Cork Institute of Technology and Institute of Technology Tralee), recently took place at University College Cork. Multiple inventions were submitted to Teagasc TTO in 2017, and from these, two finalists were selected: Kieran Meade (and Trinity College Dublin collaborators) for their 'Novel vaccination strategy targeting DNA sensors to overcome deficit in cellular immunity in neonatal calves' invention; and, Carlos Alvarez and Anne Maria Mullen (and collaborators) for their 'Procedure to generate transparent, edible and insoluble biofilms' invention. Kieran's invention was announced as the winner on the evening. The winner was selected by an external judging panel following a presentation by both finalists, and Kieran was presented with the award at the ceremony, on behalf of his team.

Innovative activity from research

Inventions are an important measure of innovative activity from research, and invention reporting is an important mechanism used within research-performing organisations such as Teagasc to capture such novel intellectual property (IP) for technical and commercial assessment. This allows the TTOs to assess these inventions/developments for patentability and commercial value, but also to capture non-patentable outputs and discoveries, including new software, databases and valuable know-how. This is a critical first step in the technology transfer process, where such IP may then be protected, thereby facilitating its exploitation by industry through the licensing or assignment of the IP.

Novel vaccine adjuvants

This invention was developed during a Teagasc-funded Walsh Fellowship project entitled 'Development of novel immunostimulators to boost the immune response in cattle', in

Pictured at the Teagasc invention of the year awards (from left): Carlos Alvarez (researcher-finalist); Kieran Meade (winner); Miriam Walsh (Teagasc TTO); Anne Maria Mullen (researcher-finalist); and, Sharon Sheahan (Teagasc TTO).

collaboration with Trinity College Dublin (TCD). It has resulted in a joint Teagasc–TCD patent application filed in 2018, entitled 'Novel vaccine adjuvants', and includes co-inventors Ed Lavelle from TCD and then PhD student Ciaran Harte. Given that vaccines hold tremendous potential for reducing the global impact of disease in humans and animals, this project, which focuses on solutions to boost the immune response in cattle through vaccine development, aligns well with Teagasc's mission and Food Wise 2025 objectives, namely, to develop new strategies to reduce the burden of disease on farm and to help secure the sustainability of the livestock sector and the safety of the food chain.

The partner TTOs are currently working to target existing human and animal vaccine producers, with a view to further developing and licensing this technology for commercialisation purposes in both veterinary and human therapeutic fields, while the researchers are considering further research funding opportunities.

Components of vaccines

At a basic level, most vaccines consist of two components – an antigen and an adjuvant. The antigen is the bacteria or virus that the vaccine is designed to protect against, whereas the adjuvant acts to amplify the immune response to ensure the long-lived cellular memory that is critical for a successful vaccine. The efficacy of current-generation vaccines can be negatively impacted by the presence of maternal antibodies, which inactivate the vaccine, or they can generate a type of immunity that is not appropriate for the specific disease-causing agent it is designed to protect against.

New adjuvant strategy

This invention involves devising a new adjuvant strategy in bovine cells to do two things: activate the enhanced cellular immunity (rather than just antibodies) required for optimal protection; and, activate innate immune cells to overcome some of the limitations of an underdeveloped adaptive immune system present in young calves. This strategy, known as 'training innate immunity', is a very novel concept in immunology. It is anticipated that this new adjuvant strategy would improve the efficacy of current-generation vaccines, as well as contributing to the tailored design of next-generation vaccines. Newer sub-unit vaccines (which contain a component of the bacterial or viral pathogens, rather than the whole organism) are a safer but less immunogenic design, which therefore rely heavily on the adjuvant to drive the formation of memory cells and thereby reduce the need for repeated booster vaccinations. The ability to drive specific protective immune outcomes through the rational adjuvant-mediated targeting of specific cellular pathways has enormous relevance, particularly in activating the immune system in young stock, and this innovation could have potential utility for vaccine design in other livestock species.

Human and animal applications

While the Teagasc–TCD collaboration focused on research into neonatal calves, TCD independently developed a similar technology with applications for human health. For this reason, Teagasc and TCD bundled the IP to file a stronger patent application covering human and animal applications. The partner TTOs are currently working to target existing human and animal vaccine producers, with a view to further developing and licensing this technology for commercialisation purposes in both veterinary and human therapeutic fields, while the researchers are considering further research funding opportunities.

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