Associate Professor Kieran Meade, UCD School of Agriculture and Food Science, explains that when it comes to livestock health solutions, the devil is in the detail

The devil is in the detail

Thanks to a world of multi-disciplinary expertise across medicine and science, we have learned an incredible amount about COVID-19 (the disease) and SARS-CoV2 (the infectious agent) in a very short period of time. However, much about the human immune response to infection and the generation of protective immunity remains unknown. In the absence of effective tools like a vaccine, control of the virus to date has been largely due to biosecurity. There are two important components of biosecurity practices. The first component reduces the risk of acquiring an infectious disease in the first place – and is called bioexclusion. The second limits the spread of infection if it occurs – and this is known as biocontainment. Biosecurity is often not given the attention it deserves but when it comes to improving human and animal health, our recent experience has shown that it will always be disease control measure number one.

The impacts of infectious disease

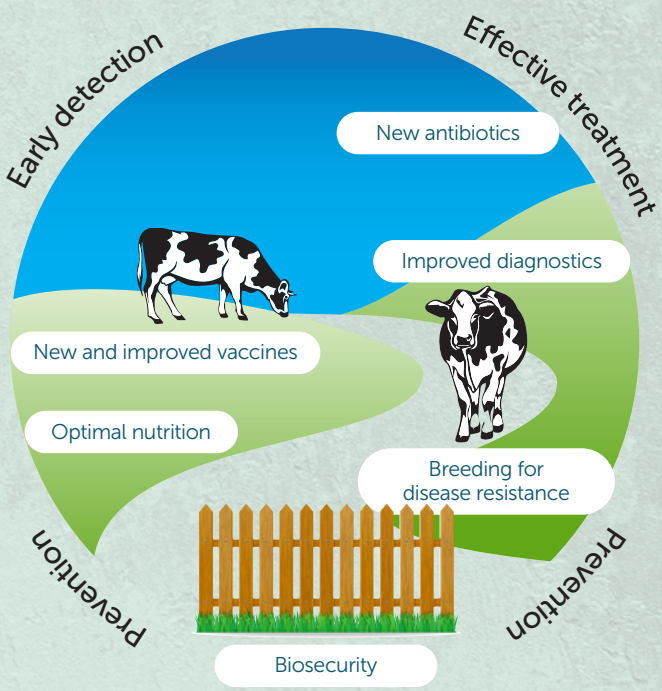
Livestock routinely battle multiple infectious agents from bacteria to viruses and parasites. Not all infectious agents move between species (zoonoses) or become pandemic but agriculture has faced up to many challenges in the past, including BSE and Foot and Mouth disease. Although the resilience of the agri-food and farming community won through in the end, farmers know only too well that infectious diseases still have a considerable widespread negative impact across farm enterprises. The impacts include on the animal – via compromised welfare and productivity; on the farm enterprise – via the lost production and treatment costs and also on the farm family in terms of mental anguish. Diseases such as tuberculosis, mastitis, parasite infections and viral respiratory diseases continue to result in mortality and morbidity. Furthermore, in an export reliant nation such as Ireland, these diseases have knock-on consequences for animal trade, consumer confidence and foster an over-reliance on the use of antibiotics. Approximately 150 reported cases of tuberculosis in humans each year across the EU are caused by the strain of the bacteria that causes tuberculosis in cattle. Reducing the burden of disease at source therefore is also critically important to secure the food chain and to protect human health. Farmers are also well aware of the important issues in relation to antibiotic and anthelmintic resistance on farms. Since the single biggest driver of antimicrobial resistance (AMR) is antimicrobial usage; and over 100 tonnes of antibiotics were used in Ireland last year in food producing animals; it is therefore logical that every effort should be made to reduce and tailor the use of antibiotics on farms.

Research advances

Easier said than done, but this is where research can advance multiple other potential mechanisms to reduce our reliance on antibiotics (see Figure). A revolution in new technologies is improving disease diagnosis, which will allow practitioners to differentiate between bacteria and viruses, for example, and thereby enable tailored prescriptions of antibiotics.

These new cow-side tests circumvent the need for detailed laboratory protocols thereby reducing costs and are designed to work in the field thereby reducing time to diagnosis. It is hoped that earlier and more specific detection of disease will translate into enhanced responses to treatment and reduced use of antibiotics.

Other productive research areas include a re-evaluation of the nutritional needs of livestock. Fighting an infection is an energy intensive process and we are only learning about the specific metabolic needs of immune cells. Understanding what is called immunometabolism will enable us to strategically intervene at specific stages in the production cycle to boost an animal's resistance to infection. It is now clear that what is important for optimal immunity is not just the quantity of energy available to livestock but the quality of specific nutrients. Our work has identified that vitamin D levels are low in the calf and spring-calving dairy cow, and multiple studies on-going to determine the benefits of supplementation on disease susceptibility. While the pipeline of new antibiotics has dried up in recent times, our work contributed to the discovery of natural antibiotics (known as host defence peptides) across a range of livestock species which may offer future hope for disease control. Like with Covid-19, the production of vaccines for livestock diseases remains the Holy Grail for long-term protection and a reduction in the use of antibiotics. We cannot simply co-opt vaccines from humans for use in livestock, there are species-specific differences in the immune response that require evaluation in order to provide effective protection. Finally some research avenues are exploring the possibility of selecting cattle with superior disease resistance. However, our knowledge of immunity in livestock lags significantly behind what is known in humans and much remains to be discovered across all livestock species. As an immunologist, my focus is on understanding how the livestock immune system works – both in health and disease. Optimal immunity underpins the successful capture of all other agriculturally relevant traits – from milk yield to weight gain and is required to enable protection from vaccines. New knowledge is the bedrock upon which innovate and sustainable science-led solutions can be built.



The path to improved animal health

Gatekeepers of the food chain

Research is critical to bridge these knowledge gaps, and identify potential new solutions to improve animal health. The advent of a 'One Health' approach is forming new partnerships between animal scientists, veterinary surgeons and human health experts to find common solutions to the diseases we have in common. Tailored treatments also reduce negative impacts of drugs on our environment via animal waste. We have learned a lot during our recent COVID-19 pandemic, and unfortunately it is true that we will continue to meet new infectious disease challenges in the future. Farmers are the gatekeepers to the food chain and guardians of human health. Over the course of evolution, hosts (like livestock) and pathogens (like bacteria, parasites and viruses) have been locked in battle and as seen in other areas of agriculture, there are many lessons to be learned from working with nature. Effective solutions means we have to grapple with the devil in the detail and therefore we need to proactively support research into animal health and develop expertise in this critically important area. Reducing the occurrence of diseases in livestock (and wildlife populations) will be a principal focus of agricultural research programmes in the coming years, as animal diseases ultimately affect us all. For more details please see: www.immunobiology.ie

Dr Kieran Meade is a newly appointed Associate Professor of Immunobiology at the UCD School of Agriculture and Food Science.