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Microbiome warfare: Bacterial Offence and Defence Systems From Microbial Communities

Professor Paul Ross

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Host: Niranjan NAGARAJAN

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11.00am – 12.00pm

GIS Level 2 – Seminar Room
60 Biopolis Street, Genome, Singapore 138672

About The Speaker

Professor Paul Ross is Director of APC Microbiome Ireland and Professor of Microbiology at University College Cork. He is internationally renowned for his pioneering research on bacteriocins, probiotics, and the gut microbiome. His work has led to major advances in antimicrobial strategies and microbiome modulation for health applications. He has published over 600 peer-reviewed articles and holds several patents. Professor Ross is an elected Member of the Royal Irish Academy and has received numerous awards for scientific excellence. He continues to drive innovation at the intersection of microbiology, biotechnology, and translational health research.

About The Seminar

Microbiomes are complex microbial communities theming with interactions from cross-feeding to direct killing as microbes battle for nutrients and space. To facilitate the latter, microbes produce various metabolites with killing potential. Bacteriocins produced by bacteria are one such example. These ribosomally-produced molecules have the potential as viable antibiotic alternatives, as natural food biopreservatives, and as our research group has shown, can modulate the host gut microbiome and even exert a physiological effect on the host.

Classified into two major groups based on the structure of the core peptide, (i) post-translationally modified and (ii) unmodified, bacteriocin production is generally encoded in dedicated gene clusters. It is widespread across the bacterial kingdoms and in the rumen alone, 38% of bacteria have the genetic potential to produce bacteriocins. We have found that a combination of in silico and culture-dependent (in vitro) methods can be highly lucrative for identifying and isolating functional novel bacteriocins from bacterial genomes and large-scale metagenomic data.

In terms of inhibition spectra, bacteriocins can be extremely narrow-spectrum, killing only closely related species. An example of this is thuricin CD, isolated in our laboratory in a search for anti-Clostridioides difficile bacteriocins which exerts minimal effects on the gut microbiome, unlike the broad-spectrum antibiotics which are used to treat C. difficile infection (CDI), namely fidaxomicin and vancomycin, and the broad-spectrum bacteriocin, nisin. Due to their proteinaceous nature, bacteriocins can be engineered for enhanced activity. We have generated nisin derivatives with enhanced anti-microbial and anti-biofilm activities and derivatives capable of targeting gram-negative bacteria.

Bacteriocins also have potential as microbiome-editing tools. Indeed, nisin has been shown to modulate the pig gut microbiome composition and functionality in a dose-response manner by reshaping the Firmicutes and altering short-chain fatty acid levels in the porcine gut. Furthermore, the activity of bacteriocins in editing microbiomes can exert physiological effects on the host. A recent animal trial by our group revealed a 6% reduction in methane from cows fed silage inoculated with bacteriocin-producing strains from week 4 of the trial. Methane is the second most significant contributor to greenhouse gas emissions in Ireland.

In conclusion, bacteriocins have evolved in bacterial kingdoms to kill bacteria, thus they represent essential tools for development in the fight against AMR and as targeted microbiome editing tools with the potential to treat chronic diseases associated with the gut microbiome and may even contribute to the fight against climate change.