pathway of *L. reuteri*, which leads to the production of acetic acid. In addition, microbiota-derived short-chain fatty acids promoted phage production in *L. reuteri* through the Ack pathway. But how does fructose metabolism contribute to phage production? The authors found that phage production required RecA, which is a component of the DNA damage response. They speculate that acetic acid production activates the SOS response in an as-yet-unknown manner. The findings provide a potential mechanism by which phages are produced in the gut in response to diet.

In the second study, Balasubramanian et al. investigated lytic induction of Shiga toxin-encoding prophage in a microbiome-replete mouse model of EHEC infection. Using this model, they found that prophage induction occurs during infection of mice with an intact microbiota. Moreover, they confirmed that the SOS response and RecA are necessary for the production of Shiga toxin and lethal disease. However, in contrast to the previous notion that infection of susceptible commensals may amplify toxin production through successive rounds of infection, the authors did not detect secondary infection of commensals. Moreover, toxin-producing bacteria that were incapable of producing phage particles caused lethal infections that were indistinguishable from the wild type. These findings suggest that although lytic induction of Shiga toxin-encoding prophage is essential for lethal disease, the production of phage particles is not required.

In sum, the studies shed light on the factors that affect phage induction and the implications for human health.

Andrea Du Toit

ORIGINAL ARTICLES Oh, J.-H. et al. Dietary fructose and microbiota-derived short-chain fatty acids promote bacteriophage production in the gut symbiont *Lactobacillus reuteri*. *Cell Host Microbe* https://doi.org/10.1016/j.chom.2018.11.016 (2019) | Balasubramanian, S. et al. Prophage induction, but not production of phage particles, is required for lethal disease in a microbiome-replete murine model of enterohemorrhagic E. coli infection. *PLOS Pathog.* https://doi.org/10.1371/journal.ppat.1007494 (2019)

which demonstrates that the co-evolution of plasmids and strains is not required for T6SS downregulation and suggests that T6SS repression provides a selective advantage to the LCP. Next, they tested whether a mutant LCP that is unable to repress T6SS could disseminate via conjugation. By comparing the efficiency of conjugation from a wild-type strain to mutant T6SS-resistant with that of the efficiency to T6SS-susceptible strains, the authors observed that the mutant LCP conjugated as efficiently as wild-type LCP into a T6SS-resistant strain, but the conjugation efficiency of the mutant plasmid into T6SS-susceptible cells was significantly reduced, demonstrating that T6SS repression is necessary for conjugation in *A. baumannii*.

The authors also observed that LCPs facilitate the dissemination of small mobilizable plasmids (SMPs), which also contribute to the MDR phenotype globally but do not encode conjugative pili. SMPs were found to mobilize into recipient cells only when the wild-type or mutant LCP plasmid was carried by the donor, but the efficiency of SMP conjugation was highly reduced when the donor cell carried the mutant LCP. These findings suggest that LCPs provide the conjugation machinery and repress T6SS in the donor cell to facilitate the dissemination of SMPs.

As most *Acinetobacter* strains constitutively express T6SS and isogenic strains are not common in nature, the authors tested whether an active T6SS affects conjugation among strains and between species. They found that T6SS provides immunity against plasmid conjugation and demonstrated that T6SS and conjugation are incompatible processes.

Altogether, these observations led the authors to propose a model of MDR plasmid dissemination in *A. baumannii* in which T6SS repression by LCPs promotes the survival of conjugants.

Ashley York

ORIGINAL ARTICLE Di Venanzio, G. et al. Multidrug-resistant plasmids repress chromosomally encoded T6SS to enable their dissemination. *Proc. Natl Acad. Sci. USA* https://doi.org/10.1073/pnas.1812557116 (2019)
FURTHER READING Harding, C. M., Hennon, S. W. & Feldman, M. F. Uncovering the mechanisms of *Acinetobacter baumannii* virulence. *Nat. Rev. Microbiol.* **16**, 91–102 (2018)

In the news

FMT IN THE CLINIC

Faecal microbiota transplantation (FMT) is the infusion of a faecal suspension containing the microbiota from a healthy donor into the gastrointestinal tract of a recipient with the aim of treating disease. FMT is effective in the treatment of recurrent *Clostridium difficile* infections, the most frequent cause of nosocomial diarrhoea, but its success in the treatment of other diseases that are caused by microbial dysbioses such as ulcerative colitis is modest, with variations in effectiveness. In some cases, FMT success has been found to be dependent on the diversity and composition of the donor microbiota, suggesting the existence of FMT 'super-donors'.

In a recent study, researchers at the University of Auckland, New Zealand, examined the findings from previous FMT trials to understand why the faeces from specific donors are better for treating certain conditions than others (*Frontiers in Cellular and Infection Microbiology*, 21 Jan 2019). By investigating what makes someone a suitable donor for FMT, Justin O'Sullivan and colleagues suggest that a high diversity of the donor's gut microbiota seems to the best predictor of the response to FMT in the recipient. For certain conditions such as inflammatory bowel disease, FMT efficacy seems to depend on the ability of the donor to provide taxa that can restore metabolic deficits in recipients that are important for a healthy gut. In some studies, it was suggested that viruses in the stool could have a role in treating specific conditions. Compatibility between the donor and recipient was also found to be an important factor; for example, the immune response of the recipient to the donor stool, and the composition of the recipient's gut microbiota before the transplant. Moreover, in addition to underlying genetic differences between donors and recipients, the diet of the recipient and exposure to drugs are also likely to affect the long-term efficacy of FMT. The team conclude that the existence of FMT super-donors is not yet supported and argue that there is no 'one stool fits all' approach, and a more personalized approach could improve the success of FMT. Commenting on the study, Rob Knight from the University of California San Diego, United States, said "Strategies to find super-donors whose stool is especially effective as a curative are still in their infancy, although progress on this topic – or making synthetic super-donors from the stool of many people – could greatly improve application of [faecal transplants]," (*The Guardian*, 21 Jan 2019).

O'Sullivan and colleagues also highlighted the lack of large randomized controlled clinical trials. A recent randomized, double-blind study of 73 adults with ulcerative colitis found that a short duration of FMT could induce remission of the disease with a 32% remission rate compared with 9% with placebo (*The Journal of the American Medical Association*, 15 Jan 2019). It was announced that a research consortium began enrolling patients in a clinical trial examining whether FMT is safe and can prevent recurrent *C. difficile*-associated disease (CDAD) (*National Institutes of Health News*, 14 Jan 2019). Investigators aim to enrol 162 volunteers who have had at least two episodes of CDAD within the previous six months. To understand the long-term outcomes of FMT, all participants will be monitored for adverse side effects for three years after treatment.

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