SYMBIOSIS

The bacteria diet

Given that a probiotic drink might contain only a billion live bacteria, compared with the one hundred trillion bacteria that are estimated to be present in the human gut, some researchers argue that probiotics must have negligible effects on the human metabolic system. However, new research published in *Molecular Systems Biology* indicates that probiotics have substantial effects on metabolism, not only by increasing the number of 'friendly bacteria' in the gut, but also by influencing the functional ecology of other gut bacteria.

Probiotics are thought to reduce the numbers of potentially harmful bacteria in the intestine, such as pathogenic

Escherichia coli and *Clostridia* spp., by increasing the sizes of populations of friendly bacteria, which ferment carbohydrates and have reduced proteolytic activity. Probiotics have therefore been used to treat numerous conditions, such as irritable bowel syndrome, and to attempt to prevent allergies in children. Martin and colleagues investigated the host response to probiotic ingestion and the biochemical mechanisms that might be involved, using a novel top-down systems-biology approach that allowed all the bacterial and host metabolic interactions to be resolved.

Germ-free mice that were colonized with human baby microbial flora were fed with a probiotic that contained *Lactobacillus paracasei*, *Lactobacillus rhamnosus* or a placebo. By counting the number of colony-forming units of each microbial species in faecal samples, the authors found that probiotics significantly altered the composition of the gut microflora. Specifically, the incidence of some bacterial species was decreased, whereas other species became more prevalent,

in a probiotic-specific manner. Nuclear magnetic spectroscopy and targeted ultra performance liquid chromatography–mass spectrometry were then used to assess metabolite levels in the liver, urine, faeces and blood of these mice. Many important biochemical changes were observed, including a decrease in very-low-density lipoprotein levels and an increase in triglyceride levels in the plasma, which suggest improvements in glycolysis and metabolism in general. Interestingly, changes were observed in the ability of mice that were treated with probiotics to metabolize bile acids, the primary function of which is to emulsify fats. The authors therefore suggest that probiotics affect how much fat the body can absorb.

This study is the first to demonstrate direct and beneficial effects of probiotics on both the composition of gut microbial populations and metabolic processes. The authors predict that future probiotic therapies could be tailored to an individual's specific metabolic make-up and ailments.

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A scanning electron microscopy image of *Bifidobacterium longum*. Image kindly provided by the Nestlé Research Center, Lausanne, Switzerland.

ORIGINAL RESEARCH PAPER Martin, F. J. et al. Probiotic modulation of symbiotic gut microbial–host metabolic interactions in a humanized microbiome mouse model. *Mol. Syst. Biol.* **4**, 157 (2008)