Exploring how what you eat and can tell you how your microbiota evolves

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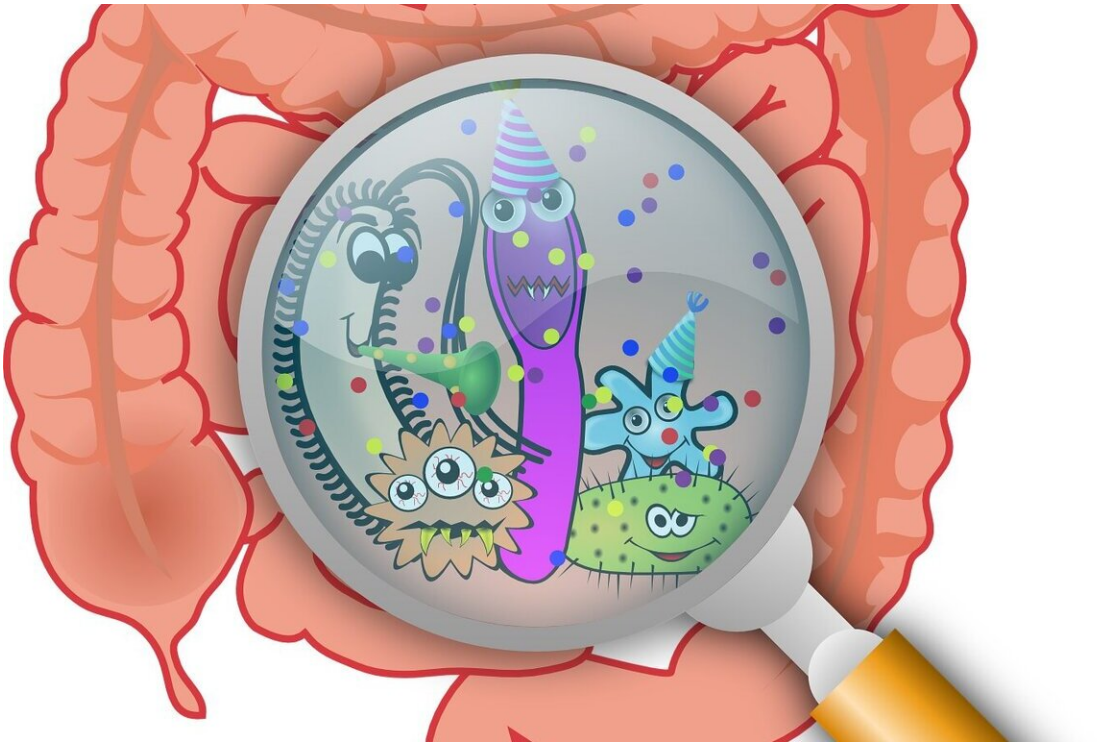

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Our gut is inhabited by a diverse community of microbes, the gut microbiota. This community, composed of hundreds of different species, is essential to our health: it influences our immune system, protects us from infections, and helps us digest food. However, many factors, such as drugs, inflammatory responses to infections, and

lifestyle can perturb the composition of the microbiota and decrease its diversity, often leading to disease.

Several gut bacteria, including B. theta, rely on dietary polysaccharides (complex carbohydrates formed by long chains) from plant fibers for their functions. Nevertheless, in the context of a low-fiber diet, B. theta can change its gene expression and metabolism to degrade polysaccharides from its host's gut mucus instead. By decreasing the thickness of this protective layer, this shift increases the host's susceptibility to infection and inflammation.

Diet is known to cause microbiota imbalances underlying a variety of pathological conditions, however, the effects of low-fiber Western-style diets on bacterial evolution remain unexplored.

New experimental data from the Instituto Gulbenkian de Ciência (IGC) revealed that, in addition to gene/metabolic regulation, the emergence of adaptive mutations in response to dietary changes can also influence and shape microbiota function. This new study followed the evolutionary dynamics of B. theta in mice that were either kept on a standard diet, rich in microbiota-accessible carbohydrates (i.e., plant fibers) and low in fat and simple sugars, or a Western-style diet, rich in fat and sugars but poor in fiber.

The authors observed that B. theta evolved rapidly in the murine gut, accumulating diet-specific adaptive mutations within a couple of weeks. While bacteria in mice on a standard diet acquired mutations that promoted fiber degradation, bacteria in mice fed a low-fiber diet accumulated mutations that favored the degradation of the host's mucus, demonstrating that these microbes evolve and adapt to distinct gut environments generated by dietary change. Importantly, since they reflect the host's diet, these emerging mutations could be used as a biomarker of dietary differences between individuals.

The study also included a group of mice that underwent weekly changes from standard to Western diet. These periodic shifts led to rapid fluctuations in B. theta's genetic and metabolic signatures, resulting in the maintenance of a higher genetic diversity compared to constant dietary regimens. According to Tanja Dapa, IGC researcher and first author of the study, these results suggest that periodic variations in diet, for example, through supplementation, might be important to avoid the fixation of specific mutations and to maintain a high genetic diversity in the members of the microbiota.

Taken together, these findings emphasize that gut bacterial evolution is an important mechanism involved in shaping microbiota function, with more permanent consequences than that of gene regulation. Such information could improve our understanding of microbiota-dependent host responses to diet and to other perturbations, including the use of antibiotics. "The consequences of an unbalanced diet can be much more permanent than previously recognized because diet affects not only the composition of the microbiota, but also leaves permanent genetic alterations in the gut microbes. Although not addressed in this study, our results indicate that these alterations can be transmitted to the next generations, thus having long-lasting consequences," reinforces Karina Xavier, leader of the IGC group responsible for the research.

The research was published in *Cell Host & Microbe*.

More information: Karina Bivar Xavier, Diet leaves a genetic signature in a keystone member of the gut microbiota, *Cell Host & Microbe* (2022). DOI: 10.1016/j.chom.2022.01.002

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