

with competition between microbes helping maintain the stability necessary to keep us healthy.

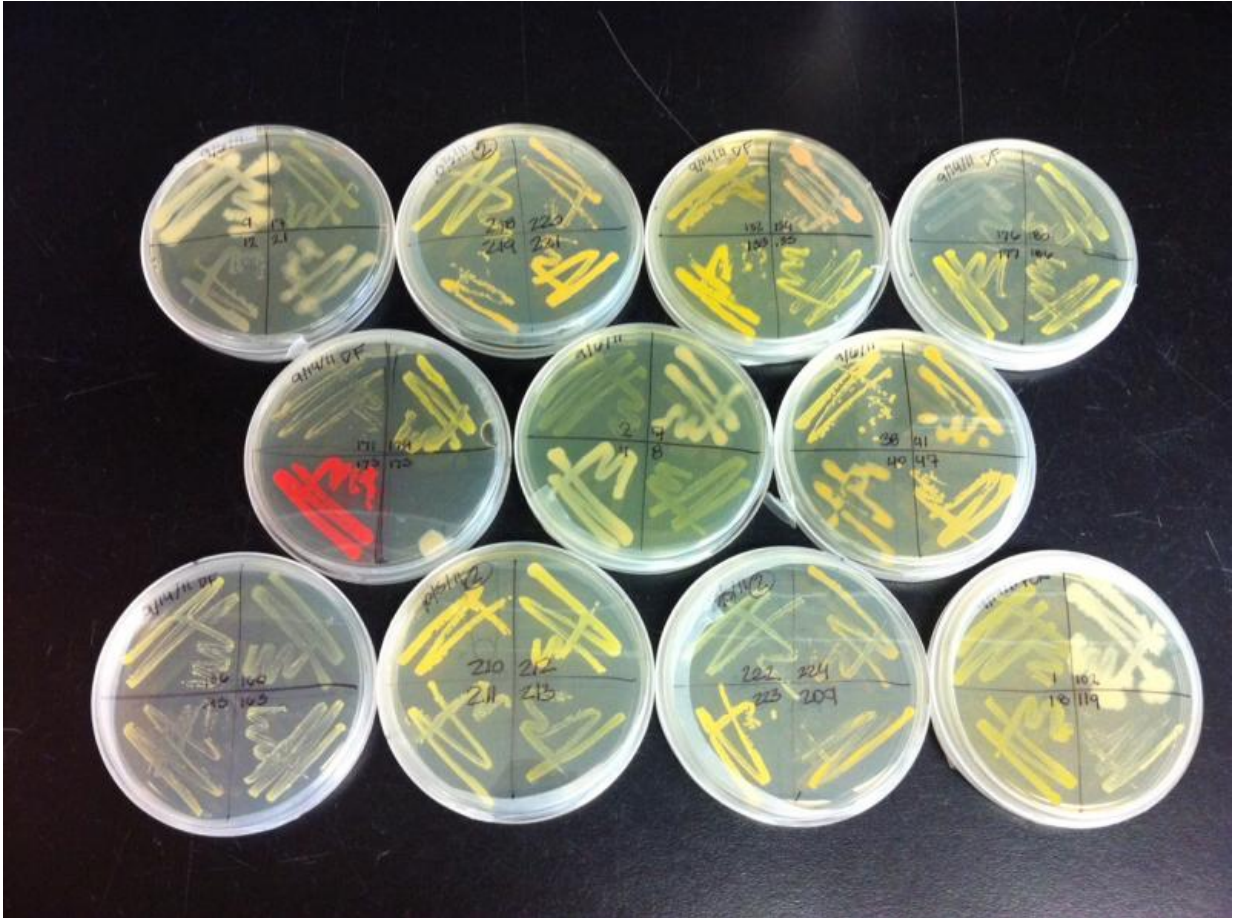
That's according to scientists at Oxford University, who have used mathematical modelling to work out how hundreds of [bacteria](#) species are able to co-exist successfully.

In their report, the researchers show that—contrary to popular assumption—cooperation between species has the effect of destabilizing the system. Instead, a [competitive environment](#) between 'good bacteria' helps to maintain stability via negative feedback loops that counteract the destabilizing effect of high species diversity.

The researchers go on to speculate that people—or hosts—may help maintain this natural stability in the gut by acting as 'ecosystem engineers' who intervene in a number of ways.

The research is published in the journal *Science*.

Kevin Foster, Professor of Evolutionary Biology in the Department of Zoology at Oxford University and corresponding author of the report, said: "We have known for some time that people carry vast communities of bacteria on and inside their bodies—particularly in the digestive tract, where these bugs are extremely important for our overall health and wellbeing. However, little is known about how these communities are able to remain stable over a long period of time.



Some of the diversity of bacterial from a grassland in southern California. Most microorganisms cannot be grown in the lab, but this shows a small slice of the thousands of species coexisting together in natural habitats. Credit: K.L. Matulich

"The assumption has always been that because these bacteria are doing us good, the communities must be cooperating with one another. What our work suggests, based on a wide-ranging mathematical analysis, is that competition may be key to a healthy gut.

"Rather than cooperating like plants and bees, whereby a reduction in one species will drag down the other, we think that the bacteria act more

like trees competing in a dense jungle."

Understanding the massive communities of microbes that we carry inside us—the microbiome—is fundamental for our health because they provide us with many benefits, including the breakdown of food, protection from pathogens, and maintaining a healthy immune system.

The gut microbiome is often noted for its ecological stability. Different people may carry different microbial species, but any one individual tends to carry the same key set of species for long periods. This stability is considered critical for host health and wellbeing, and, correspondingly, major shifts in microbial community composition are often associated with ill health.

Professor Foster added: "The hypothesis we put forward is that hosts actively intervene to help maintain the stability created by the competitive environment.

"One obvious way to do this is through the immune system suppressing overabundant bacteria, but another option is to keep different [species](#) of [good bacteria](#) apart so they don't end up overly reliant on one another."

More information: "The ecology of the microbiome: Networks, competition, and stability," by K.Z. Coyte et al. *Science*, www.sciencemag.org/lookup/doi/.../1126/science.aad2602

Provided by Oxford University

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