Beneficial microbes are 'selected and nurtured' in the human gut

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Animals, including humans, actively select the gut microbes that are the best partners and nurture them with nutritious secretions, suggests a new study led by Oxford University, and published November 20 in the open-access journal *PLOS Biology*.

The Oxford team created an evolutionary computer model of interactions between gut microbes and the lining (the host epithelial cell layer) of the animal gut. The model shows that beneficial microbes that are slow-growing are rapidly lost, and need to be helped by host secretions, such as specific nutrients, that favour the beneficial microbes over harmful ones.

The work also shows that the cost of such selectivity is low: the host only needs to use a very small amount of secretions to retain beneficial microbes that would otherwise have been lost.

"The cells of our bodies are greatly outnumbered by the microbes that live on us and, in particular, in our gut," said Professor Kevin Foster of Oxford University's Department of Zoology, an author of the new paper. "We know that many gut microbes are highly beneficial to us, protecting us from pathogens and helping us with digestion, but quite how such a beneficial mutual relationship evolved, and how it is maintained, has been something of a mystery."

"This research highlights the importance of growth-promoting substances in our ability to control the microbes that live inside us. It

shows that nutrients are more powerful when released by the host epithelial cell layer than when coming from the food in the gut, and suggests that controlling our microbes is easier than was previously thought."

Jonas Schulter, also of Oxford University's Department of Zoology and first author of the paper, said: "The inside of our gut is rather like a war zone, with all kinds of microbes battling it out for survival and fighting over territory. Our study shows that hosts only have to secrete a small quantity of substances that slightly favour beneficial microbes to tip the balance of this conflict: it means that favoured microbial species that would otherwise be lost don't just survive on the epithelial surface but expand, pushing any other strains out."

The team's simulations show that cells affected by host epithelial selection are least likely to be lost, and instead persist longest, causing 'selectivity amplification', whereby relatively tiny changes instituted by the host (in this case a very small amount of secretions of certain compounds) can be amplified to produce a large-scale effect.

The study may have wider implications than the human gut: selectivity amplification may occur in a range of other interactions between hosts and microbes, including the microbes that grow on the surface of corals and the roots of plants.

More information: Schluter J, Foster KR (2012) The Evolution of Mutualism in Gut Microbiota Via Host Epithelial Selection. PLoS Biol 10(11): e1001424. doi:10.1371/journal.pbio.1001424

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