

Hydrogen-powered invasion

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Salmonella Saintpaul bacteria (dark red)

Although mankind is only just beginning to use hydrogen as an energy source, the concept has been established in nature for a long time. Researchers at ETH Zurich have discovered that the diarrhea-causing bacterium *Salmonella* uses hydrogen as a source of energy to colonize the intestine.

The intestine is bustling with billions of [intestinal bacteria](#) that aid digestion and keep it healthy. A vast array of microorganisms ([microbiota](#)) colonise the intestine so densely that pathogens do not usually stand a chance of multiplying. However, some pathogens, such as the diarrhoea-causing bacterium *Salmonella* Typhimurium, still manage to invade this densely populated ecosystem. Researchers at ETH Zurich are a step closer to finding out how they do this trick and discovered where the pathogen obtains the energy from for its attack.

Wolf-Dietrich Hardt, Professor of Microbiology at ETH Zürich, together with his PhD student Lisa Maier, examined which factors play a role in the early stages of a Salmonella attack. During the invasion of the intestinal ecosystem, Salmonella Typhimurium uses an enzyme that helps it to assert itself against microbiota: the hydrogenase enzyme, which converts hydrogen into energy. "Although we already knew that Salmonella Typhimurium can use hydrogen in addition to many other sources of energy, it was not clear which source of energy it used during this early stage of intestinal colonisation," explains Maier.

Theft-based hydrogen economy

Hydrogen is created in the intestine as a chemical intermediate of the microbiota's normal metabolism. "Salmonella therefore operates a theft-based [hydrogen economy](#) by stealing energy from the microbiota to assert itself," says Hardt. Because the microbiota metabolism of most animals works in a similar way, the pathogen can find the necessary energy source for its initial attack in any new animal host.

Once Salmonella Typhimurium has managed to multiply inside the intestine, the bacterium invades the intestinal tissue and causes infection and diarrhoea. In some cases, Salmonella Typhimurium even finds its way into the bloodstream and internal organs. However, animal experiments have shown that the energy boost from hydrogen does not play an essential role during this process. "Outside the intestinal lumen, Salmonella Typhimurium does not have to create space for itself in a dense community of microorganisms," explains Maier.

The Achilles' heel of intestinal flora

The hydrogenase enzyme is also found in other bacteria, such as Escherichia coli and Helicobacter pylori, which causes stomach ulcers.

The researchers therefore suspect that other pathogens also use the [hydrogen](#) produced by [intestinal flora](#) as a source of energy. This would make the microbiota's own metabolism an Achilles' heel in the defence against a range of germs.

"The purpose of intestinal flora is to protect against infection. However, we are now seeing for the first time that it can also facilitate infections by serving as an unintentional energy provider," says Hardt. The interaction between microbiota and pathogens is thus more complex than initially thought.

More information: Maier L, Vyas R, Cordova CD, Lindsay H, Schmidt TSB, Brugiroux S, Periaswamy B, Bauer R, Sturm A, Schreiber F, von Mering C, Robinson MD, Stecher B, Hardt WD: Microbiota-Derived Hydrogen Fuels Salmonella Typhimurium Invasion of the Gut Ecosystem. *Cell Host & Microbe*, December 11, 2013. [DOI: 10.1016/j.chom.2013.11.002](#)

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