Pathogen predicament: How bacteria propel themselves out of a tight spot

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Scientists have deciphered how some types of "swimming" bacteria have evolved to be able to escape when trapped in small spaces.

The discovery could pave the way to finding new methods to stop the spread of certain bacteria, including species that cause food poisoning and stomach ulcers.

Many bacteria can swim, allowing them to seek out new sources of nutrients, or in the case of pathogenic bacteria, infect and spread.

Almost all swimming species of bacteria propel themselves forward using corkscrew-like propellers called "flagella". Bacterial flagella are composed of thousands of protein building blocks arranged in spiralling chains.

A multidisciplinary team of scientists, including researchers from the University of York, has discovered that some types of bacteria have evolved complex flagella made up of many different types of proteins to enable them to manoeuvre themselves out of small spaces.

The scientists looked at a soil-dwelling species of bacteria called Shewanella putrefaciens and found that when they get stuck in a tight space their multi-component flagella buckle, wrapping around the cell bodies and allowing them to corkscrew free.

Co-author of the study, Dr. Laurence Wilson, from the department of physics, said "the question of why some bacteria such as E.coli have flagella made up of one type of protein while others have more complicated flagella made up of many different types has been a longstanding mystery.

"Nature likes to keep things simple. In any 'machine', more components mean more things that could go wrong. Our study has shown that complicated flagella have a function which helps bacteria escape when they get stuck in tight spaces, an advantage which outweighs the cost of maintaining genes to encode the various protein building blocks".

For the study, scientists at the University of York used their world-class high-speed holographic microscopy expertise to follow cells in 3-D, allowing them to see how cells use their flagella to swim and spread.

International colleagues from the Institute of Microbiology and Molecular Biology in Geissen, Germany, carefully established where the different building blocks lie within individual flagellum. Computer scientists from The Philipps University of Marburg, Germany then built a series of simulations that allowed them to test the effect of slowly varying the physical properties of the flagellum.

They found that the building blocks in the flagella of Shewanella putrefaciens are arranged in the optimal way as when they removed or swapped around the flagella components, the bacteria's ability to swim, either in "open waters" or in tight spaces was impaired.

Dr. Wilson added: "Species of bacteria such as Campylobacter jejuni, which causes food poisoning, and Helicobacter pylori, which causes stomach ulcers, have been found to maintain multiple components in their flagella.

"This study gives us a better understanding of the physics of bacterial infection—knowledge which could lead to new ways of blocking the transmission of harmful infections in the future

'Spatial arrangement of several flagellins within bacterial flagella improves motility in different environments' is published in *Nature Communications*.

More information: Marco J. Kühn et al, Spatial arrangement of several flagellins within bacterial flagella improves motility in different environments, *Nature Communications* (2018). DOI: 10.1038/s41467-018-07802-w